Growing Fruit and Vegetable Crops

BY

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72 Illustrations

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The subject matter arrangement of the chapters and their average length of from 10 to 12 pages, make it possible for them to serve effectively for either 1 or 2 lessons each. Since both study and class periods often vary markedly for various reasons this feature appeared worthwhile.

A high purpose has been to adapt discussions and information to the reading level of students rather than teachers. Undergraduates of agricultural colleges and vocational agricultural classes have been kept constantly in mind in order to serve them best. It is believed that other groups including members of garden clubs and various agricultural organizations may find the information helpful as a guide and a good reference.

In the groups of both fruit and vegetable crops, due and adequate attention and prominence have been given to individual, leading and important crops. Yet an equal effort has been made to give proper significance to crops of less popularity and value. From the outset, a chief purpose was the completion of a well-balanced book on the growing of fruit and vegetable crops. Furthermore, separate treatment of the crops has been sufficient to enable the reader to advance step by step and from crop to crop without becoming confused as to which crop the cultural suggestions may be applied. Pictures of high quality have been used freely and effectively to supplement the subject matter. Each illustrates a point or supplies additional suggestions or information.

The author expresses sincere appreciation and thanks to colleagues and co-workers who have made valuable suggestions in connection with certain parts of the manuscript. Particular acknowledgment is due the following from the University of Missouri for careful reading, criticism of various chapters and the giving of suggestions for handling the production:—Dr.

R. A. Schroeder; Dr. V. N. Lambeth; Dr. D. D. Hemphill; Dr. A. D. Hibbard; Prof. H. G. Swartwout; Dr. A. E. Murneek; Prof. Lee Jenkins; Prof. V. F. Burk and Roger Williams, Missouri Store Co., Columbia, Missouri. Thanks and acknowledgments are also due Ernest Roberts, Superintendent of the University of Missouri Horticultural Farm for assistance in procuring photographs and finding and selecting material for photographing.

Grateful acknowledgment is made for the assistance received from the use of pictures from the files of the Department of Horticulture, University of Missouri. Various state agricultural experiment stations, United States Department of Agriculture, American Fruit Grower and others have also cooperated freely and effectively. Under each illustration credit as to source is given.

Columbia, Missouri T.J.T.

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Growing Fruit and Vegetable Crops

Chapter 1

Origin and Improvement of Fruit and Vegetable Crops

AFTER three centuries of growing horticultural crops in the United States, the element of chance continues to make plant improvement interesting and fascinating to both producer and plant breeder. It is well that this is true because the introduction of a new variety may have profound and far-reaching effects upon the extension of fruit and vegetable culture and the consumption of their products.

Notable and classical examples of this are recorded in the histories and descriptions of these crops. For example, a great revival of interest and enthusiasm in grape culture followed closely the introduction of the Concord variety. Likewise similar encouragement to producers and consumers occurred with the coming of the Wilson strawberry, the Elberta peach and the Delicious apple. Similar advancement and progress has been made with such vegetables as tomatoes, sweet corn, watermelons, muskmelons, Irish potatoes sweet potatoes.

The opportunities for the improvement of fruit and vegetable crops are almost unlimited. The development of new and better plants by hybridization is by no means limited to these now being grown in home and commercial plantings. It is well known that wild plants have been the source of most cultivated kinds. Naturally, the most striking and outstanding fruits and vegetables were the first to be selected from the wild state. It is possible that many of the less spectacular ones were left or neglected. That some of these may be worthy is illustrated by the blueberry and tomato which have in a comparatively short time been changed, improved, and now recognized and sought on the markets by consumers everywhere.

Also modern knowledge and technique have shown that there is still unusual opportunities in native and wild plant introductions from foreign countries and America. The careful selection of superior strains alone may make many worthy and a few tremendously valuable.

DEVELOPMENT AND IMPROVEMENT OF VARIETIES

In general, the development and improvement of varieties are due to the choice of chance seedlings, the procuring and utilization of worthy mutations (bud sports), and the selection of hybrids from breeding or hybridization investigations. That all kinds of fruits and vegetables need further improvement is fully recognized. Varieties are desired that have higher dessert, better shipping, storing and keeping qualities. Sorts more suitable for particular purposes and show improvement in adaptation to different regions and adverse conditions are desired.

It is well known that the perfect variety does not exist. Yet, it is equally as well understood that the possibilities for improvement are vast. Furthermore, a variety that may be particularly well suited for home uses because of its delicate texture, fine flavor and superb quality may not possess satisfactory handling and shipping requirements.

BY CHANCE SEEDLINGS.—Most of the important varieties of fruits now in cultivation originated as chance seedlings. Seeds dropped by chance in fields, fence rows, gardens, ravines and in other locations, sprouted and developed into seedling trees, shrubs and vines. When these were worthy they often attracted attention and finally were reproduced by vegetative methods (budding and grafting) and brought to the attention of producers.

The improvement of fruits by means of the selection of the best wild seedling sorts has been practiced since the beginning of history. Methods of budding and grafting were known more than 2000 years ago. The superior varieties grown in Europe in the seventeenth century, had all developed as chance seedlings. The best varieties were propagated vegetatively. The growers even at this early date knew that fruit crop seeds are likely to produce plants that are not true to type and that it was necessary to use budding and grafting to reproduce the varieties desired.

BY BUD MUTATIONS.—Now and then cell division in the vegetative tissues of plants may fail for some reason to reproduce a new cell exactly like the parent. This results occasionally in the growth of a branch or bud that varies in some respects from the other branches and buds of the parent tree. If the variation is a true mutation it may be reproduced when propagated vegetatively. These so-called bud sports or mutations may occur as individual leaf, branch, entire tree or fruit variants.

With a growing interest in red sports of the apple particularly, there has been a rather intensive search of apple orchards throughout the country to find mutations of merit. This effort has been stimulated due to the fact that apples possessing a deep red color usually command higher prices on the markets than apples streaked with red or partly covered with shadings of light red colors. Also, red sports have generally been comparatively easy to find and interest in them has been heightened.

Already it is claimed that there are more than 30 red strains of the Delicious variety. As many as 15 red strains of the Rome Beauty are now known, 20 strains of Winesap, 8 strains of Stayman Winesap, and several strains of York, Jonathan, McIntosh and of still other leading varieties. At this time, it is believed that there are strains in existence for nearly all the chief red or blushed apple varieties that color earlier, or possess superior

color. In spite of the general impression among nurserymen and growers, mutations may vary from the parent in more than one character. It is well known that variations in productiveness, dessert quality, season of ripening, fruit size, storage quality or others may or may not accompany color variations of the fruit. Also, sporting characters are just as likely to be worthless as they are to be valuable. It is very important, therefore, that bud mutations be thoroughly studied and investigated by competent or well-trained individuals before they are widely propagated and disseminated.

Through selections it has been fully demonstrated that fruit color can be improved. Furthermore, worthy bud mutations, perhaps, offer the most rapid method of improvement of the present standard varieties. For example, by bud selection, it is possible to find an earlier maturing Stayman Winesap or one that does not have the fault of fruit cracking near harvest time or that may possibly be less susceptible to winter cold injury of trunks and branch crotches.

By Hybridization.—Hybrids result from the crossing of two or more varieties. It is generally conceded that hybridization offers the greatest possibilities for definite and new types and for the incorporation of new characters that may include improved production, increased vigor and hardiness in both fruits and vegetables.

In all breeding or hybridization work, the objective is to combine the desirable characters of varieties in order that one or more may be improved or intensified. It may produce sorts that bloom later in the spring and as a result are less likely to be injured by late spring freezes or frosts. The purpose, also might be to develop greater resistance to disease and insect attack, improve the quality and flavor as well as size and to develop early and heavy production.

At best, many years may be involved in plant breeding, selection, and testing of seedlings before a new type is found that is actually better than the parent varieties or leading sorts. The results are sure to be very uncertain. Hundreds or even thousands of plant seedlings may be produced and examined for years without finding one that may actually be considered better than varieties that are now being used.

However, now and then better sorts with distinctly improved characters are produced. The results, therefore, may after many years finally prove very worthwhile if only one better variety is found. This is true because nothing, perhaps, may improve or change the horticultural industry so markedly as the introduction of a new and better variety.

The United States Department of Agriculture and nearly all the State Agricultural Experiment Stations are carrying forward helpful and constructive fruit and vegetable hybridization projects. Some new and important varieties have been developed and introduced from controlled crosses. Some of these include the Blakemore and Catskill strawberries, Latham and Sodus raspberries, Fredonia and Seneca grapes, Golden Jubilee and Eclipse peaches, Ovid and Gorham pears, and Lodi and Macoun apples. Some varieties of vegetables notable for their resistance to plant diseases are Mary Washington asparagus, Marglobe tomato, Hollander cabbage, Well's Red Kidney pea bean, and Virginia Savory spinach.

Patience, Ability and Optimism Required.—Plant breeding for improved and more desirable varieties requires great foresight, enthusiasm, industry and patience. With most kinds of fruits from 5 to 10 or more years may be needed to grow the plant from seed to bearing age and to evaluate it in comparison with other varieties. Additional years will be needed for propagation of promising kinds. In the case of apples, as much as 25 years may be required from the time a cross is made until the progeny has been properly tested and its value accurately determined. Then still more years will be needed for commercial orchards to come into bearing.

The strawberry may require less time for hybridization, testing and evalution than most other fruits. Yet actual experience has shown that for careful work and accurate evaluation studies, 15 or more years may lapse before definite knowledge and conclusions can be reached.

Vegetables may in general require less time for improvement by hybridization than fruits. In fact, they are often designated as "short term crops." For example vegetable seed produced from controlled crosses may be planted the following year and crops produced. In the case of fruits like apples and pears, seeds from crossings may produce plants that require 8 to 10 years to produce fruits.

Varieties, therefore, developed from crosses, must travel a slow, rough and rocky road. The shortcomings and faults of nearly all will overtake and destroy 90 per cent or more of them while just starting on the road to introduction. Only a few out of thousands may be strong and capable enough to withstand the tests and pass the critical examinations imposed. However, with the tremendous number of experiments and observations now being made of hybrid seedlings throughout the country, the prospects are bright for the coming of varieties superior to those now in use.

Creation of New Varieties.—A Gamble.—The sowing of fruit seeds produced in the open or uncrossed may be compared to throwing dice to see what will turn up. Never the less, the sowing of over a bushel of apple seeds by Peter M. Gideon gave one seed that produced the Wealthy apple. More than a million seedlings of the soft maple were grown by D. B. Wier and inspected carefully to find one plant in the collection with finely divided leaves that gave us Wier's cut-leaf maple. Where thousands of seedling mulberries were growing in a nursery, Mr. Teas observed one plant that had a sprawling or trailing habit of growth. This plant was perpetuated and extended by grafting it upon the upright growing species and Teas' Weeping mulberry was the result.

Introduction of Delicious Apple.—Perhaps few realize the merest chance saved the Delicious apple and that tremendous hazards were encountered and overcome in its introduction. Jesse Hiatt upon finding a seedling-apple sprout in his orchard and believing it worthless cut it down. Next spring the seedling grew up again, making a stronger growth than ever. "Well," observed Mr. Hiatt, "you are so determined to grow, you will be given a chance."

Upon the production of the first fruits, the owner believed that the quality of the fruit, size, shape, aroma and other factors made it a worthy apple. He named it the Hawkeye and in later years the fruit was exhibited at local and county fairs. It attracted little attention and standard variet-

ies usually won the prizes and recognition. The promotion of the Hawkeye was continued and finally after about twelve years of waiting, working, enduring discouragements and disappointments, the rights of propagating and selling were sold to a commercial nursery. This story illustrates the long, hazardous and disappointing road that new and even worthy varieties may have to travel before introduction.

APPLE IMPROVEMENT

The original habitat of the apple according to the best authorities seems to be the area east of the Caspian Sea. The wild apples that grow in this region now are believed to be much like the originals of early times. They are in size about 1 to 2 inches in diameter, astringent in taste, strongly acid in flavor and greatly inferior to the modern apple of today.

The improvement of the apple goes back to the earliest recorded history. Cato of the third century, B.C. is reported to have known seven different varieties of apples, and Pliny of the first century, A.D. knew 36 varieties. Also, when the first settlers began to arrive in America hundreds of apple varieties had been grown and named in European countries.

Many of the first settlers of the Eastern Coast of North America brought with them apple seeds, and frequently grafted trees of the best European varieties. In a few years after the coming of the settlers, the records show that plantings of apple trees were bearing fruits and that growing apples for home uses was a fairly common practice.

Apple trees and seeds for new plantings were disseminated rapidly. Indians, missionaries, and traders soon penetrated the wilderness and established plantings far from the borders of the settlers. Many of these early apple and peach orchards near Indian villages remained long after they were abandoned.

Naturally most of the early plantings of those that pushed Westward consisted of apple seeds. As the apple does not come true from seed, the fruit grown varied widely in size, color, quality and season of ripening. The varieties best suiting the needs of the producers were selected from time to time for vegetative propagation (grafting and budding). It was not long, therefore, before new varieties were found that were as good or better for the new country than the European sorts.

IMPROVEMENT OF PEAR VARIETIES

Varieties from Europe and their seedlings are so susceptible to attack of fire blight that pear growing on a commercial basis with these varieties has not developed except in a few sections. Where blight is present, relatively cool summers and mild winters appear to be needed for the growing of European sorts, including the Bartlett, the pear of commerce. The warm, humid summers of other sections of America make the production of these blight-susceptible varieties questionable.

The sand pear (Pyrus serotina, Rehd.) was introduced in the United States in 1840. It proved to be relatively resistant to fire blight. The

fruit is coarse-fleshed and usually contains a high percentage of grit cells. Being blight resistant, the sand pear was distrubuted widely in eastern United States. Chance hybrids between the sand pear and European varieties followed. Most of the crosses occurred naturally between the European pear (Pyrus communis) and the sand pear (P. serotina) by growing the trees in the same orchard and through planting seed of the fruit harvested. The most important hybrids resulting from the open crosses were Le Conte, Kieffer, Garber, Douglas and Pineapple. In quality of fruit and texture of flesh all of these are inferior to the European pears.

However, they are resistant enough to fire blight to permit the growing of trees and the production of fruit in most parts of the central and eastern United States. Plantings are largely for home uses and small commercial outlets. Our highest quality pear varieties have nearly all been introduced from Europe. The most important of these are Bartlett, Anjou, Bosc, and Winter Nelis. Varieties orginated in the United States have been those selected particularly because of their resistance to blight.

Objectives of Pear Improvement.—Some of the most important objectives of pear breeding in this country may be briefly listed as follows:

1. To secure varieties resistant to fire blight and that possess satisfactory dessert qualities.

2. To obtain varieties having hardiness sufficient to withstand the cold winters and dryness of the Great Plains area.

3. To supply blight resistant pears of high dessert and culinary quality that mature their fruit from early summer until late fall.

IMPROVEMENT OF STONE FRUITS

Peaches, Plums, Cherries and Apricots

In the United States the growing and production of stone fruits constitutes an important and extensive industry. In a record year, peach production alone has reached over 86 million bushels. Also census figures show that 45 million bushels of peaches, more than 23 million bushels of plums, and 5 million bushels of cherries may be produced in one year. All of these fruits except cherries are consumed in large quantities in the fresh, canned, and dried state. Dried peaches in the United States amounts to about 200,000 tons annually and California produces nearly 75 per cent of the dried prunes used in world consumption.

As imposing and important as this record of stone fruit production is, yet the work of variety improvement has just been started. The search for better fruits must be continued. Plant breeders will continue to use every worthwhile method at their command and they will endeavor to combine desirable characters in such a manner as to develop superior stone fruits.

Peaches

A good example of the need for fruit improvement is strikingly illustrated by a consideration of the Elberta peach. It is generally known that this

variety is the leading commercial peach in the United States. Although originated in 1870 at Marshallville, Ga., and now 83 years old, no other peach has been found to take its place when all factors are considered.

Yet it is well known that the variety has faults. The tree and the blossom buds are not as resistant to low winter temperatures as desired. Many varieties possess much better quality and are more attractive than this peach. It is true that some crosses with Elberta have produced seedlings with higher quality and increased winter hardiness. These varieties have for reasons such as lack of adaptation, poor handling quality and for still other objections failed to replace the parent. It is possible, however, to still obtain the goal of developing a variety superior to Elberta. Such an accomplishment would be an outstanding contribution to the peach industry.

Plums

Of the stone fruits, plums rank next to the peach in commercial production and the fruits are prized highly for their great range in size, color, flavor, and texture. The plants vary in forms and shapes. Some are trees, others are small shrubs with drooping branches. Upright and spreading habits of growth are exhibited. Some attract a great deal of attention on account of their beauty in bloom, the aroma of the blossoms and the beauty of the foliage and highly colored fruits.

As many as 12 species of plums may be found in American orchards and in the wild. Nearly all the commercial varieties are included in four of the species. The plum breeder has an abundance of varieties, types and species available for his work.

Prunus domestica varieties, the European plums and prunes, are the best known and most important of these groups. However, they do not thrive in sections where hot, dry summers or dry cold winters are common. In the sheltered areas along the Great Lakes, Pacific Coast States, Intermountain sections and northeastern United States, soils and climatic conditions suitable to their culture are found.

Cherries

Although not grown as extensively as the peach and plum, yet the cherry is an important stone fruit. Two groups, sweet and sour make up the varieties of commerce. The sweet cherries are used chiefly for fresh-fruit dessert, while the sour varieties include most of the frozen and canned products for use in food-serving establishments, bakeries, and homes. Cherry pie has a ranking near that of apple pie and the sour varieties are often designated as pie cherries.

Objectives in Breeding Cherries.—In as much as the production of sweet cherries is now limited to a few favored and sheltered regions, there is a great need for high-quality sweet varieties that will prove hardier in tree and blossom characters than many now being planted. The finding and selection of more cold resistant understocks is needed. Disease resistant varieties particularly are in demand for the southern sections of the United States.

Apricots

By many the apricot is considered the most pleasing and delightful of the stone fruits. However, very few apricots are grown for fresh fruit east of the Rocky Mountain region. Consumers generally, therefore, are best acquainted with the canned or dried product, because its culture is restricted to sections where climatic conditions are favorable.

In general, the varieties can withstand winter temperatures comparable to those of the peach, but the blossom buds may bloom a week or more earlier than peaches. As a result, crops are frequently destroyed by late freezes and spring frosts. The fruit probably originated in western China and some hardy strains came from Siberia.

Although one of the earliest fruits used by man, comparatively little systematic work has been done to improve apricot varieties. Modern methods, however, and a greater appreciation of the value of the fruit is sure to stimulate plant breeding.

FIG. 1.—Armore, a new strawberry released by the Missouri Agricultural Experimental Station in 1949. It is a cross between Blakemore and Premier. The berry is believed to have most of the good qualities of its parents without the bad ones. It produces abundant crops of large size berries over a longer period than its parents, possesses good handling and shipping qualities, rates well in quality, a good plant maker, and promising for both commercial and home production. (Mo. Agr. Exp. Sta.)

STRAWBERRY IMPROVEMENT

The strawberry as we know it today differs from other fruits in that most of the chief varieties now being grown have been developed by plant breeding. Chance seedlings have not played nearly as important a role in improvement as they have with other fruits. The industry is comparatively young as commercial development has occurred since about 1865. Nearly all the commercial varieties in use now have originated within the past 45 years and 70 years ago production was limited to the districts near a few large cities. Strawberries are now grown in every state in the Union, as well as in the interior of Alaska. Interest in the culture of the fruit and the gradual extension of commercial production has been made possible by the introduction of improved varieties.

The origin of firm varieties such as the Aroma and Wilson adapted to varying conditions and commercial handling have been a great stimulus to increased production. The ability to secure strawberry varieties that will succeed from sea level up to an elevation of about 12,000 feet in both humid and dry regions has extended production for all purposes. It is a desirable and popular berry with producers. The important uses of the strawberry, its attractiveness, high dessert quality, and harvest in early summer before other fruits are available give it a unique and an enviable position on the markets everywhere.

Although substantial progress has been made in strawberry breeding work, accomplishments to date are considered just a good beginning. Varieties of firmer flesh, higher in quality, suitable for freezing, better plant producers, and capable of increasing production materially are needed. Sorts of fruit both earlier and later than those now in use, that have greater winter cold resistance and that are less likely to serious attack of diseases and insects are being sought.

GRAPE IMPROVEMENT

Grape breeding is relatively new. There is need for information on the inheritance of characters having to do with size, quality, seedlessness, cold hardiness, insect and disease resistance, and adaptability to environment.

Breeding work has dealt mainly with the improvement of quality. This has been brought about by crossing with the best varieties of the European grapes. The type of cluster and type of berry have been improved by combining the desirable factors of native species. Hybridization has developed rootstocks which have suitable resistance to phylloxera. The stocks also have been adapted to various soil types.

The extensive grape breeding program of Germany is perhaps the largest of its kind ever undertaken. Also, ten species of native grapes have furnished about 2000 varieties to American viticulture. Few if any other fruits offer such a wide selection of uses, sizes, colors, flavors and aromas.

BLACKBERRY AND RASPBERRY IMPROVEMENT

Although much has been accomplished by plant breeding in improving the varieties of blackberries and raspberries, there still remains much

to do for further improvement. Some plant breeders are especially interested in crossing our named varieties with the European sorts in order to increase fruit size and quality including firmness, vigor of plant and resistance to diseases. All will agree that we have large quantities of material for plant breeding work and that it offers splendid opportunities for the goals sought.

Blackberries and raspberries have not been given the attention in improvement work that other fruits have received. This is natural because these fruits are newer in commercial uses. The need for their improvement, however, is desirable and important. Many of the experiments now under way for improvement deal with the origination of hardy, thornless forms. Another problem that may be solved through plant breeding is greater drought resistance as well as increased yields. The progress made toward the development of varieties suitable for growing in the South is significant. We may look forward confidently, therefore, to better varieties in the future, to higher production, improved quality, greater resistance to diseases and insects and more acceptable varieties for handlers and consumers especially in the South.

CURRANT AND GOOSEBERRY IMPROVEMENT

As with other fruits the combining of characters that will improve the size and flavor of the fruit, resistance of the canes to disease and insect, injury, drought conditions and extreme winters is the goal. Some hybrids already possess some of these sought qualities and there are others that appear to be in the offing. Both of these fruits offer great opportunity for the development of improved varieties that would meet the needs of both home and commercial growers. The breeding work of the North and South is sure to bring forward crosses that may be of value to both sections of the country. This is needed because the varieties of the South are not as resistant to drought conditions particularly as they should be. In fact, both fruits need extension in the areas or regions where drought conditions and dryness prevail because most currants and gooseberries are much better suited to cooler and more moist conditions than exist in many sections of the country.

THE PLANT PATENT LAW

Since 1930 the United States Government has issued plant patents to protect the originators of any distinct and new variety of plant. It is gratifying to note that an amazing number of new horticultural plants have since been patented. The passage of this Plant Patent Act gives the same protection to the patentee of a new plant variety as is given to one who has had a patent issued him on a new mechanical invention. The plant breeder enjoys the same monopoly of 17 years for his new variety of plant and he can prevent others from infringing upon his rights by reproduction of his new variety of plant. Any person who invents or discovers a new and distinct variety of plant other than a tuber-propagated plant, can obtain a patent for the exclusive right to propagate that plant

by asexual reproduction, that is, by grafting, budding, cuttings, layering, division and the like, but not by seeds. License may be granted by the patentee to others to grow, use, sell, or do any or all of these, in certain territories for limited periods.

GENERAL VEGETABLE IMPROVEMENT

The Federal Government and the State Agricultural Experiment Stations are now carrying forward research and experiments in vegetable breeding projects having to do with disease resistance particularly.

FIG. 2.—Topcrop, a round, green-podded snap bean of high quality and resistant to mosaic. This new bush-type is a 1950 Gold Medal winner among the All-American selections. It is considered the best variety now available for commercial use in many big producing areas. For the small garden it is also promising. (Photo by Bureau of Plant Industry, Soils, and Agricultural Engineering, U.S.D.A.)

Efforts are being made through plant improvement to develop superior varieties in yield, quality and hardiness. Other studies include insect control, drought resistance, and extending the range or adaptability both North and South. Still other problems of growers are being considered. Knowledge and assistance, therefore, is being extended as rapidly as conditions, funds and help permit and needs require.

Two groups of vegetables will be discussed briefly as examples of the type of work which is being done to develop vegetable varieties resistant to diseases. All the other chief kinds of vegetables are being given similar attention. This is especially true where control is dependent mainly upon varietal resistance.

Improvement of Tomatoes, Peppers and Egg Plants

State and Federal agencies are doing more plant improvement work and investigating the problems of producers more extensively each year. The objective is to serve the vegetable industry better. Diseases constitute the most important problems in many instances. In fact, a new strain or variety would not be considered worthy of introduction unless it were resistant to one or more diseases of major importance.

A great portion of the research may consist of carefully planned efforts to determine, locate and combine plant characters that will help to improve the disease resistance of new varieties. At the same time, equal efforts are made to find sorts that are resistant to injury by heat and cold, and adaptable to long-distance shipments.

Improvement of Cucurbits

The curcubits belong to the family Cucurbitaceæ. They are in many respects similar and consist of cucumbers, muskmelons, watermelons, pumpkins, and squashes. There is comparatively little genetic knowledge available regarding cucurbits. However, noteworthy results from systematic breeding projects with muskmelons, watermelons, and squashes have recently added materially to the fund of information on the genetic nature of these crops.

An outbreak of powdery mildew in the Imperial Valley, California, some fifteen years ago, furnishes an excellent example of the value of resistant varieties in combatting plant diseases. A three-year search for resistant varieties was made by the U.S.D.A. Among melons imported from India, careful testings, and selections showed several to be resistant to mildew. After an additional four years of systematic breeding, testing and selection work, Powdery Mildew Resistant Cantaloupe No. 45 was released for the use of growers. In addition to being markedly resistant to mildew, it possessed superior shipping qualities. In this section, the mildew problem has now been handled in a manner that has proven satisfactory to producers generally.

Chapter 2

Growth and Fruitfulness

HORTICULTURAL plants exist in a wide variety of sizes and forms. While to the casual observer there may seem to be but little similarity between trees, shrubs, herbaceous plants, and vines, yet all horticultural plants have much the same general make-up.

The smallest structural units of the plant are the cells which may be compared to the individual stones and bricks of a building. Although similar in essential characteristics, plant cells vary in size, shape, function, arrangement, structure and composition. Most cells are so small in size they cannot be seen except through the aid of a microscope. When one realizes that about fifty million or more cells may be contained in a single apple leaf, their very small size is given greater emphasis. Furthermore, plants grow or increase in size and differentiate or change into different forms through cell division, cell extension or enlargement and cell maturation.

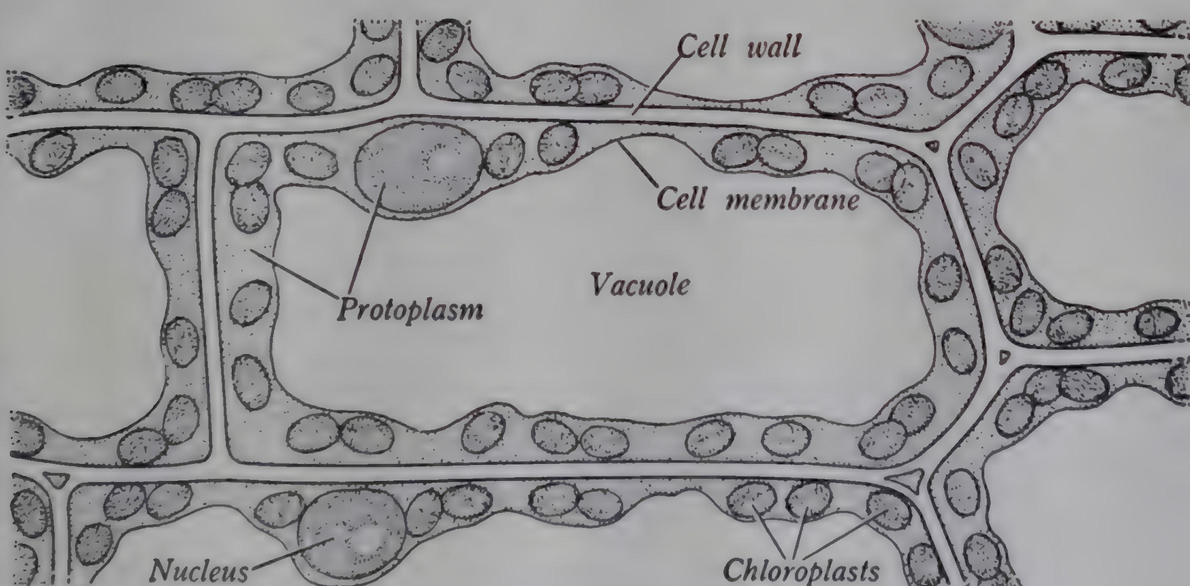

FIG. 3.—A cell (much enlarged), with its important parts. (Phillips *et al.*, Agriculture and Farm Life, 1939, courtesy of the Macmillan Co.)

CELL DIVISION. Growth includes the development of new cells, their increase in size and their changes into different types of tissues. Growth occurs in the meristematic tissue which is made up of cells that have the ability to divide and enlarge. Such tissues are usually found at the tips of

the roots and stems. The buds and other, more or less specialized plant parts, and the cambium or growing regions of stems and root terminals contain cell-dividing tissues. It is important, therefore, to know that growth is confined to these parts of the plant.

Cell Extension or Enlargement.—Nearly all cells after being formed by division have the ability for a considerable period to enlarge and develop. The plant tissues composed of thin-walled cells usually of a spherical shape are very common and they are known as parenchyma. The edible or fleshy parts of fruits and some vegetables such as turnips, melons, and celery are composed chiefly of the so-called parenchyma cell tissues. The cells of these tissues continue extension or enlargement during most of the growing season.

For about 30 days after bloom, the growth of the peach fruit is due to cell division. However, the later increase in size of the peach is accounted for by the enlargement of the cells originally formed. The tomato fruit is quite similar to the peach fruit in enlargment of the cells soon after growth is well started. For example, after the tomato fruit is about $\frac{1}{3}$ inch in diameter, later increase in size is due entirely to cell enlargement.

Cell Maturity or Maturation.—The changes that take place in cells after they have reached maturity or attained normal size and development are usually termed maturation. Good examples consist of the changes that occur to form such tissues as phloem, xylem, cork, etc., of woody stems or trees.

SOME FACTORS AFFECTING GROWTH

Both internal and external factors affect growth. Those characters inherent to the plant itself are designated as internal growth factors. On the other hand, the factors that are associated with the plants' environment or surroundings are known as external growth factors.

Internal Growth Factors

Young plants and their parts usually make more rapid growth than old plants or old plant parts. Furthermore, growth is particularly more rapid during the early period of the plants' life cycle than during the later stages. The exact or specific reasons for this condition are not fully known or understood.

Plant Heredity.—The general growth characters are determined by heredity. Plants inherit certain characteristics such as size, form and appearance. To a considerable extent heredity may control the amount of growth that plants make. It is well known that plants naturally dwarfed in size cannot be made to grow as large as other plants that do not possess the dwarf habit.

Regulators of Growth.—Regulating influences of nitrates in the soil and fumes and gases from smelters that pollute the atmosphere have long been known and observed carefully. More recently, however, we have

become acquainted with products called hormones and vitamins which have influence on plant growth and are frequently termed growth regulators. These growth accelerators or growth inhibitors are manufactured by the plants themselves.

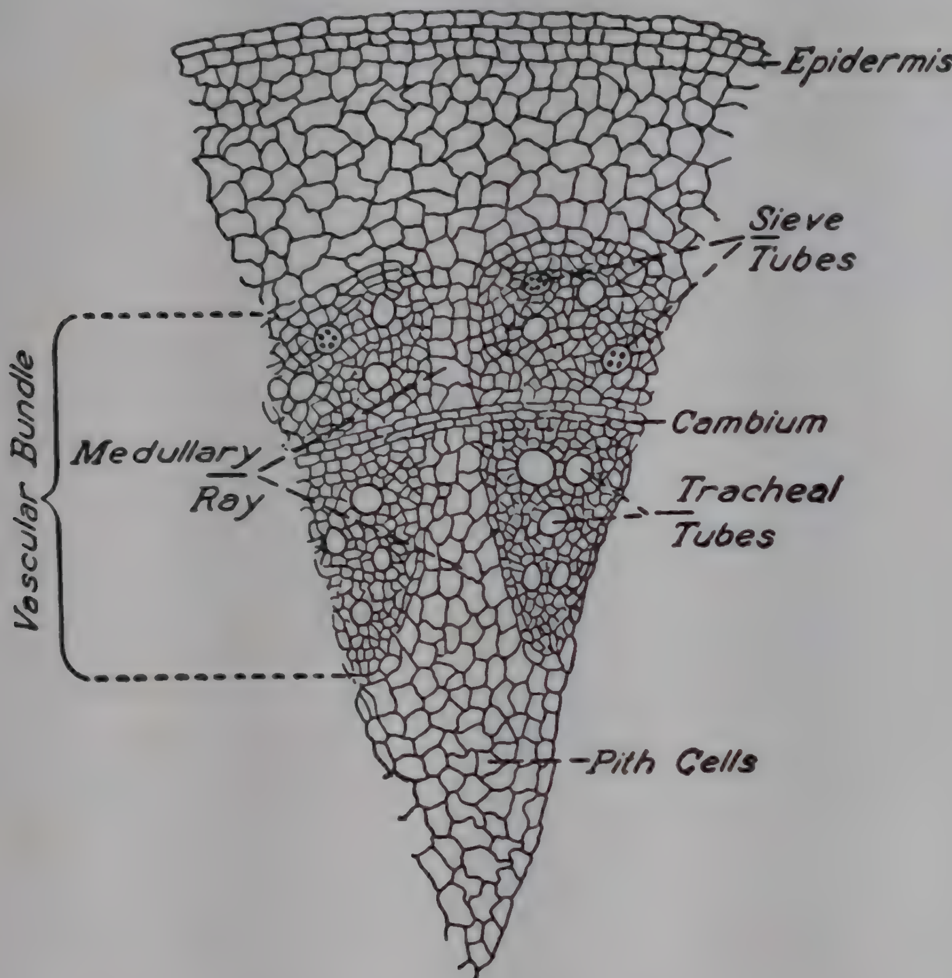

FIG. 4.—Section of a woody stem with vascular bundles close together and the pith between compressed into medullary rays. (Horticulture for Schools, courtesy of Miles N. Wood.)

External Growth Factors

LIGHT INTENSITY.—Light has a tremendous effect upon the growth and development of plants. The intensity of light varies with the day, with the season, and with the distance from the equator. During the day it increases gradually from sunrise to the middle of the day and similarly decreases to sunset. It is high in summer, moderately high in spring and fall, and low in the winter. Likewise it is highest at the equator and decreases gradually toward the North and South poles. Light is required in the process of photosynthesis. It supplies energy for the combining of carbon dioxide and water to form carbohydrates. Naturally, other factors being equal, the greater the amount of energy within limits, the larger the rate of photosynthesis or the manufacture of carbohydrates.

LIGHT DURATION.—The period at which plants flower may be determined by the amount of food they manufacture during light duration. Some plants like spring radishes and delphinium flower during long days only.

Others such as selected varieties of chrysanthemum, flower during the short days only. Also, strange as it may appear, still other plants like the tomato may flower during both the long and short days.

Furthermore, the length of day may influence the development of food storage organs such as onion bulbs. Studies have also shown that short days may favor the development of tubers of some varieties of potatoes.

Perhaps the florist, has made the fullest practical and economical use of the effect of light duration on vegetation and reproduction. Long-day plants are induced to flower earlier than normally by giving additional light in greenhouse production. On the other hand, certain short day plants are caused to flower earlier than normally by excluding the light by covering with cloth during the long days. The marketing season may thus be considerably shortened or lengthened as desired for cropping purposes.

TEMPERATURE.—The growth, fruitfulness, and maturity of plants is dependent upon certain temperatures. Each species and variety has a minimum temperature below which growth does not take place. Likewise there is a maximum temperature above which growth does not occur. Between these extremes of minimum and maximum temperatures, every kind or type of plant has an optimum temperature at which the best growth and fruitfulness takes place.

WATER.—One of the great determining factors in plant growth and fruitfulness is water. Too little or too much water may limit or stop growth entirely. Water is the vehicle for transfer of the food materials manufactured by the plant and of the raw materials absorbed into the plant. Also, water is an indispensable component of active living protoplasm.

NUTRIENTS.—The chief nutrient elements considered essential to plant growth are carbon, oxygen, hydrogen, nitrogen, phosphorus, potassium, calcium, iron, sulphur and magnesium. In addition to these nutrients required in available amounts, the so-called "trace" or "minor" elements are required for good growth and fruitfulness. The elements are boron, copper, zinc, manganese, and molybdenum. Although required in extremely small amounts as compared to the major nutrients, yet the trace or minor elements frequently become limiting factors. Both oxygen and hydrogen are obtained from the water absorbed from the soil, while carbon is secured from the carbon dioxide of the air. The other nutrients are obtained from the soil.

SOIL CONDITIONS.—Plants grow best in a congenial soil environment. The soil provides mineral nutrients, water and anchorage for the plants. In the soil the roots must be able to carry on respiration and other important processes. The spaces between the soil particles are normally occupied by air and water. After heavy rains or irrigation the spaces may become almost completely filled with water. When this occurs the soil is said to be saturated. Usually, most of this water drains away fairly rapidly and each soil particle is left surrounded by a film of water. In this condition, the water content of the soil is referred to as being at *field capacity*. The water is held partly by capillary forces and partly by colloidal forces. It is the capillary water which is absorbed chiefly by plant roots. The

colloidal water exists in such thin films and is held so tenaciously it cannot be used by the roots.

Through soil surface evaporation and absorption by plant roots, the moisture films around soil particles may become very thin and finally the soil becomes "air dry." Such soils may still contain colloidal moisture but the thin film is not sufficient to support plant life.

The roots of nearly all land plants die in a soil that continues to be saturated with water for considerable periods of time. This killing of the roots is due to lack of aeration. Soil air is required for maintenance of respiratory and other essential life processes of the roots.

MISCELLANEOUS FACTORS.—Many other external factors may influence the growth of plants. Some of these are atmospheric influences such as wind, rain, hail and dust. Poisons or toxic substances and harmful fumes and gases may also influence plant growth or even destroy it. Also, diseases and insects are always present in varying degrees.

Plant Growth and Limiting Factors

Growth proceeds normally when all the factors capable of influencing it are favorable at the same time. Frequently one factor, as a lack of moisture, may retard or stop growth completely. Limiting factors, therefore, are those that curtail or stop growth by themselves. Rarely, if ever, do all the factors that may be involved limit growth at the same time. Ability to promptly recognize limiting factors of plant growth may aid the grower materially in adopting remedial cultural practices.

Growth Periods

Growth and non-growth periods are normal for horticultural plants. However, the growth periods vary greatly with different plants and with the climatic conditions under which they are produced. For deciduous trees and shrubs, the growth and non-growth periods are fairly clearly defined. There is less distinction in the growth periods in the case of evergreen plants. Also, growth and non-growth periods is more clearly marked in the temperate than in the sub-tropical or tropical regions.

The most noticeable indication of growth occurs when the buds in early spring unfold and shoots and leaves develop. This activity begins when all the environmental conditions are favorable. Generally the start is slow but the rate of growth increases rapidly toward late spring and early summer. This most rapid period of growth is often termed the "grand period of growth." Following this stage, the activities of the plant slow down in late summer and fall and finally stops completely. Plants in the tropical and sub-tropical climates have a different schedule of growth. Usually there is no maximum or grand growth period but the plants may have several growth periods within the same season.

Non-Growth Periods

During non-growth periods plants do not increase in size. Although few if any indications of growth may be observed, the plants are not

entirely inactive. The forms of non-growth periods are: (1) *dormant* periods and (2) *rest* periods. There is a fundamental difference between these periods which should be understood thoroughly. In fact, the periods may occur in the same plant at the same time and one may overlap the other.

THE DORMANT PERIODS.—The time during which a plant makes no growth due to the prevailing surrounding unfavorable conditions is called the *dormant* period. Such plants resume growth when the environmental conditions become favorable again. The apple in the temperate regions under normal conditions reaches the dormant period in the fall when temperatures gradually become too low for growth. In the spring when the temperatures rise sufficiently high, growth is resumed.

THE REST PERIOD.—This is the condition that develops gradually in woody plants, that prevents them from growing, even when environmental factors are favorable for growth. Naturally, the rest period varies greatly with different plants. Some plants, including the deciduous fruit trees, have rather long and persistent rest periods. On the other hand, some plants have very short rest periods and in still others it may not be noticeable as the plants grow whenever the conditions are favorable.

In the case of apple varieties, the rest period may begin in July or August. For peach varieties, it generally occurs in August and for strawberries it may be as late as October in starting.

To break the rest period and make it possible for plants to grow under favorable conditions, chilling weather or low temperatures are required. It is generally known that many seeds will not grow until the rest period is broken. Such fruit trees as pears and peaches may need a temperature of 45° F. or less for a period of 25 to about 40 days to break the rest period in order that resumption of growth may occur. Apple trees may require a longer period of chilling or as much as 40 to 50 days of exposure to such temperatures.

IMPORTANCE OF DORMANCY AND REST PERIODS

Perhaps the most important significance of these periods is that through their influence, some plants are able to withstand successfully climatic extremes of cold, heat and moisture. All of the so-called hardy plants endure dormancy and experience rest periods. For example, some of the lilies begin and complete their growth in the early spring when moisture and temperature factors are favorable. Following this they go into a resting period which makes it possible for them to withstand severe drought conditions in summer and fall.

Deciduous fruit trees such as apple, peach, pear and nut trees including the walnut and pecan are typical in illustrating the influence of the rest period. This is true because they can be grown only in areas where sufficient winter cold occurs to break their rest periods. If the rest periods of these fruit trees and nuts are not broken, as frequently happens in mild climates, the trees fail to produce leaves and flowers the following spring. The trees may remain dormant or partially so and may even die. In tropical and sub-tropical areas, the lack of sufficient chilling weather to break the rest

period is the main reason for the unfruitfulness of such fruit and nut trees.

Nitrogen compounds and carbohydrates seem to be of major importance in growth and fruitfulness. The living part of all cells is made up of nitrogen as the main element. The non-living parts of the plant cells consists almost entirely of carbohydrate materials. In addition, perennial fruit-producing plants usually carry large quantities of carbohydrates and some nitrogen as storage reserves.

Initiation of Flower Buds.—The causes of flower bud initiation are not known with certainty. Recent evidence points to the production by leaves of a special flower-forming substance or hormone which is translocated to and accumulates in certain parts of the plant, such as spurs and twigs. As a result of this hormone concentration, fruit buds are initiated. For their initiation very little nitrogen or carbohydrates seem to be required. Their further development into flowers and fruits, however, very probably is controlled by the quantitative supply of nitrogen and carbohydrates. Hence, whenever necessary nitrogen fertilizers are applied especially at the time of fruit setting, the carbohydrate supply is assured by the maintenance of an abundant and healthy leaf area. When there is a deficiency in nitrogen or carbohydrate substances, flower buds, although initiated, may not develop into functional flowers and any flowers that are produced may not set and mature fruit.

There is apparently no satisfactory experimental evidence available to show that a certain carbohydrate-nitrogen relationship determines growth and another relationship fruitfulness. Classification of fruit bearing plants in such a manner, however, might help the grower to determine the nutritional state of the plant and suggest remedies in the form of certain orchard practices.

CARBOHYDRATE-NITROGEN RATIO

Plants are frequently grouped into four classes according to their respective growth and fruitfulness and the proportion of carbohydrates and nitrogen in their tissues. These classes may be briefly described as follows:

Class I.—In this group, the plants show a marked deficiency of carbohydrates. Such a lack of starches and sugars (carbohydrates) may be due to a low rate of manufacture brought about by defoliation, shading or other factors that have reduced the rate of carbohydrate formation. The plants grown may be termed weakly vegetative and some may fail to reach the full blooming stage and thus produce no fruit. The color of the foliage may be a light green and the stems soft, thin and willowy. Partial or complete defoliation by insects, diseases, and the application of improper sprays may have occurred. Trees or plants in this state of growth or nutrition bear little or no fruit. Young trees near the bearing age may be classed here.

Class II.—Rank-growing and vigorously vegetative trees and plants having large, thick stems and heavy foliage may be grouped in this class. In contrast with Class I, the foliage is dark green in color, and the stems and leaves exhibit a state of rank or luxuriant growth. Nearly all of the carbohydrates may be used in growth and there is no storage in the plant tissues. Trees before reaching the bearing period or if forced into vigorous

growth by severe pruning or too much fertilization, one or both, are likely to fall into this group or class. Naturally, little or no fruit is borne in this state of growth. The use of excessive quantities of commercial nitrogen or manure may induce such rank growth.

CLASS III. In this class, the proper balance sought between nitrogen and carbohydrates may have been attained. The adjustment of nutrients,

FIG. 5.—A 14-year-old apple tree in the fruitful state. The hands of the orchardist show the current or one season of growth, which is about 10 to 12 inches. Evidently there is a proper nutritional balance for good fruiting between the nitrogen and carbohydrates. (Mo. Agr. Exp. Sta.)

gives a fair to good growth and the set and development of a satisfactory crop of fruit. In this class carbohydrates are not limiting as in Classes I and II. The objective of the grower should be to continue or maintain this nutritional condition. Furthermore, a judicious use of sprays, fertilizers, fruit thinning, and soil management may go a long way toward obtaining the goal—good growth and fruitfulness.

CLASS IV.—This is the nutritive condition most often found in apple orchards. This may be particularly true for old bearing trees growing in sod lands. A deficient amount of nitrogen exists with an abundant quantity of carbohydrates. This results in an extremely weak growth, yellow or light colored foliage, and the growth of few flowers or many flowers too weak and devitalized to set fruit. The remedy consists of supplying properly

additional quantities of nitrogen, proper pruning and cultivation, one or all as required. This should give increased growth, and adequate fruit bud formation and blossom growth, and a satisfactory set of fruit. The nutritional condition for good fruiting may be changed, therefore, by adopting one or all of the following practices: Fertilizing with manure or commercial nitrogen, good pruning practices, and cultivation systems including the use of cover crops.

FIG. 6.—Again the hands of the orchardist show the growth for one year on a 6 year-old apple tree that is coming into bearing. Note the length growth for the one season which averages from about 2 to 3 feet. This represents the vegetative state, where there is an abundance of nitrogen and a comparatively small amount of carbohydrates. (Mo. Agr. Exp. Sta.)

TREATMENT INFLUENCING FRUITFULNESS

Cultural practices such as cultivation, pruning, fertilization, irrigation, and the growing and plowing under of both legume and non-legume cover crops are methods employed by good growers. This is true because these practices may influence materially the growth and production of fruit and vegetable crops. Growers generally, therefore, must be concerned with the state of growth and fruitfulness of orchards, vineyards, gardens and truck crops in order that regular and paying returns may be received.

Effect of Soil Organisms on Plant Growth

Soil scientists maintain that soil organisms (fauna and flora of the soil) may compete successfully with the higher plants for soil nitrogen. Such competition may or may not be beneficial. On soils where plants are making a rank or heavy vegetative growth due to available nitrogen in excessive amounts, the use of nitrogen by soil organisms may prove helpful. On the other hand, in the case of plants making a slow and poor growth, on account of a deficient supply of nitrogen, the utilization of nitrate nitrogen by soil organisms would be injurious by depleting still further the soil nitrogen.

The action of soil organisms, therefore, is the explanation of nitrogen deficiency symptoms on herbaceous crops which have been sown or planted after plowing under straw, old non-leguminous hay, leaves, and mature green-manuring crops. It also explains the retarding or slowing up of growth, when spring-planted herbaceous crops are mulched with straw. Also, we find in these explanations reason for applications of sodium nitrate and ammonium sulphate. The commercial nitrogen fertilizers facilitate the decomposition of the straw, green-manure cover crops and the like. In fact their timely and proper use may prevent the retarding of growth by supplying nitrogen for use in plant growth and for utilization by the soil organisms.

Questionable Methods of Inducing Fruitfulness

Such practices as bending, ringing, notching, scoring, and root pruning have been used for the purpose of slowing up growth and inducing fruit bud formation, blossoming and fruiting. It is well known that young apple and pear trees in a vigorous state of growth, when subjected to one of these treatments, may form or develop a large number of fruit buds for the crop the following year.

Where such practices are employed they interrupt or change the usual growth processes. Complex organic compounds including carbohydrates and hormones are built up above the girdled area and fruit buds are developed. If ringing, girdling, scoring, etc., are performed in early spring, blossoming is not affected during the same year. Furthermore, when the work is done in August blooming is not affected the following spring.

For these methods to be effective, they must be performed properly and at the correct time. Observations and experiments have shown that about 20 to 30 days following the blooming period is usually satisfactory. It should also be remembered that the practices are designed for over-vegatative trees and certain varieties that are prone to come into bearing comparatively late. Rarely if ever is it advisable to ring trees which are making a poor or unsatisfactory growth. As a matter of fact, these practices may have a detrimental effect on weak and devitailized trees. There exists considerable evidence that the treatments may even contribute materially to the killing of starved and stunted trees.

Scoring.—This practice has to do with the cutting of the bark down to the wood in a circle all the way 'round the trunk or large scaffold branches.

Scoring is the least severe or mildest type of girdling. Naturally, growth is inhibited to a less extent than for ringing and notching. This is true because in ringing approximately $\frac{1}{4}$ inch of bark is removed in the circle around the large branches or the trunk. With notching, a strip of bark of similar width is removed and in doing so the notch may extend into the wood to a depth of $\frac{1}{4}$ to $\frac{1}{2}$ inch.

Bending and Root Pruning.—These methods have effects on fruiting similar to scoring, girdling and notching. Trees and plants are grown in pots and other receptacles to induce dwarfing by inhibiting root growth. Cutting the roots with a long sharp spade around trees and the bending of the branches above, one or both, tends to restrict growth and cause a concentration of food materials above and the formation of fruit buds as is true for the other practices. It is obvious that girdling the large scaffold branches is less likely to injure the trees seriously than girdling the main trunk. If one or even more of the large branches are damaged seriously or killed, the tree may still be of some value.

Value of Such Growth Inhibiting.—The employment of these methods in the growing of fruit is questionable. Equally as good or better results may be obtained in slowing down growth and inducing fruitfulness by adopting less severe and dangerous practices. For example, the withholding of fertilization, cultivation and heavy pruning will tend to inhibit or slow up growth. Consequently the net effect may be a proper balancing of nutrients, particularly carbohydrates and nitrogen, favorable to the development of fruit buds and fruit setting.

In the hands of the grower these girdling practices should never be employed to cause fruiting until after all other procedures have failed. Both student and producer, should understand the fundamental effects of girdling. The knowledge may prove helpful and valuable in diagnosing and interpreting growth and fruiting problems.

The stone fruits, such as peaches, cherries and plums are not suited to girdling practices. Their tissues may not heal rapidly enough to cover the wounds inflicted. Treated trees may, therefore, be seriously injured or killed.

EVERY FRUIT AND VEGETABLE CROP A DIFFERENT PROBLEM

General recommendations may be made which will be applicable to many fruits and vegetables. It is obvious, however, that all orchards and gardens should not receive the same type of treatment. For the individual crop, a careful analysis should be made of all the problems involved. With this information, care and culture depend upon the particular conditions of growth and fruitfulness for the trees or plants considered.

Good culture in one instance might be unsatisfactory in another, even in the same locality. The grower should remember, however, that pruning, fertilizing, cultivating, irrigating and the use of cover crops may have a marked effect upon the carbohydrate and nitrogen content of the trees or

plants and that all of these may contribute toward the conditions sought—good growth and fruitfulness. A lack of these practices may also have an effect on growth and fruitfulness but in the opposite direction. All of the plant nutritional conditions should be considered collectively, therefore, when plans are made to modify or change *any* of them.

GROWTH REGULATORS

In describing the effects of growth regulators on plants such terms as growth promotion, arousing growth activity, inhibiting growth, delaying growth, altering growth, and other names are used widely. Good examples of the use of regulators are to prevent the preharvest drop of fruits, increase root growth on hard and soft wood cuttings, promote increase in fruit set, delay blossoming of fruit trees, influence seedlessness in fruits, extend dormancy, thin fruit, promote fruit maturity, hasten fruit coloring, reduce water loss in fresh vegetables, ripen fruit artificially, destroy noxious weeds and woody plants, and dwarf plant growth.

Growth Regulators Puzzling

Much is yet to be learned about growth regulators. When conditions are favorable, the so-called "hormones" are usually most effective. Young, immature, and growing terminals or shoots may be materially affected by applications. The substances may be produced naturally in plants. When this is true, the term, "hormone" may be correctly applied as in animal terminology. However, 2,4-D, naphthaleneacetic acid and other similar products used in weed killing, blossom thinning and prevention of fruit drop do not occur naturally. They are, therefore, incorrectly called "hormones." Hence, "growth regulators" appears to be a better name for all substances having somewhat similar action on plants.

Still on Trial

Those best informed regarding the use of growth regulators for fruit and vegetable crops maintain that in general these chemicals are still "on trial." However, all will admit that they are here to stay. Rapid and valuable progress has been and is still being made. The stage is set and the foundation is laid for perhaps even greater and more startling developments. Gradually but surely within a few years procedures and materials will be available and standardized for the use of all. In the meantime the employees of the State Agricultural Experiment Stations may be consulted for reliable and authentic information. There are no better sources for help in the proper handling of state-wide and local problems pertaining to growth regulators.

Cultivation of the various kinds, good seedbed preparation, fertile soils including abundant supplies of nutrients and timely irrigations when need cannot be replaced through the use of weed killers or growth regulators. In fact, one should try to adopt the best known cultural practices and use them wisely and economically before considering seriously the use of growth regulators.

Chapter 3

A New Enclosure For Horticultural Crops

THE multiflora rose (Rose multiflora, thunb), now seems to offer a solution for the high cost of farm fencing. This living hedge fence may serve effectively as both a barrier and low windbreak. Also, its use does away with the fence maintenance problem. In general, the plant is considered new to most sections of the country. However, it is the hardy understock upon which many of the garden roses have been grafted or budded for many years. Originally the plant came from Asia. The name "Multiflora" means many-flowered, referring to the many white flower clusters that resemble the flowers of blackberries.

FIG. 7.—Two-year-old multiflora rose hedge fence being used as an effective barrier. (Mo. Agr. Exp. Sta.)

The thorny shrub is comparatively easy to establish. Yet it is not difficult to eradicate should the need arise. The hedge does not spread from the planting site by roots or suckers. Birds may carry the seeds and in some instances a few plants have appeared in the vicinity of the rose fences. The oldest hedge fences, however, supply no evidence that the rose may become a pest. Plantings of fruits and vegetables may be made right up to the hedge as it does not offer objectionable competition. The roots tend to grow downward instead of spreading laterally. In fact, rows of crops adjacent to the hedge may show greater vigor and yields, due perhaps to the lessening of evaporation and stunting effects of fairly strong winds. Studies have shown that the rose fences do not harbor as

many field mice, chinch bugs and other insects injurious to crops, as weed and grass fence rows and ravines. This is possibly due to the excellent cover given wildlife insect predators such as quail, other birds, skunks, foxes and the like.

HEIGHT AND SPREAD.—The multiflora rose hedge grows to a height of about 7 to 9 feet and to a spread of 7 or 8 feet in about 5 to 6 years. In

FIG. 8.—A six-year-old multiflora rose hedge fence supporting a 200-pound man standing on a stepladder placed on top of the hedge and near the center. Note the height of the hedge even under great weight. (Mo. Agr. Exp. Sta.)

later years these dimensions in growth do not appear to change materially. New canes grow up and the old ones die. The mass of canes with thorns, therefore, tends to increase in density and become more impenetrable each year without growth extension in spread or height. The Multiflora does not require clipping, pruning, training or other support maintenance costs. The length of life is long, as specimen plantings of more than

75 years are still in excellent condition and capable of serving as effective barriers.

As a Windbreak.—This Asiatic rose has been employed as a low windbreak with good results. It may prevent soil erosion, soil blowing, snow drifting and wind damage. The plant is used alongside or across gullies, irregular soil surfaces and, for fencing terraces and water outlets. The washing away and erosion of ditch and pond banks may be prevented through its proper use. The fibrous root system of the plant tends to make it valuable for erosion control and especially so when used as a contour fence. Close spacing of the plants in setting usually increases the effectiveness for such purposes and as a barrier against livestock for the first 4 to 6 years after planting.

Other Uses.—As a cover for quail and other forms of wildlife it is of great value. This is especially true in prairie regions, on bottom lands, and where there are little or no permanent winter harbors. It may also serve to an advantage as an enclosure for wildlife areas. The rose is colorful in flower, foliage and fruit, and its shape and form renders it valuable for use in beautifying both the home grounds and the farmstead. The bountiful seed crops of a reddish orange color supply a dependable source of food for many different kinds of birds during the winter season.

Plant Is Variable.—The multiflora rose is notorious for its great variability. Some have thorns, others are thornless. Upright, spreading and trailing kinds may be found. The plants may also vary markedly in vigor. For hedge fences and windbreak purposes it is important to select the upright, thorny, vigorous type which grows a mass of dense recurving canes from the ground to a height and spread of about 7 to 8 or 9 feet.

Time Required to Grow a Barrier.—The time required for the rose to make a satisfactory barrier will vary with the soil fertility, planting care, culture and site. On the experimental grounds, University of Missouri, College of Agriculture at Columbia, under conditions of fairly good soil and culture, a barrier effective against horses and cattle was developed after two years of good growth. Farm plantings in other sections have also formed effective barriers at the beginning of the third year. On tight, poor or droughty soils and where little care is given the plantings, a longer period may be required to produce hedge fences as satisfactory barriers against livestock and especially for hogs, sheep, and goats. Under good growing conditions, however, year-old seedlings spaced 6 inches apart and with a satisfactory stand of plants should produce effective fences against all types of livestock in 3 to 4 years.

Unlike the Osage Orange.—The rose is a shrub and not a tree; hence it will occupy much less ground than the osage orange. It has the signal advantage of requiring no trimming to keep it in bounds. Its initial vigor, particularly on the poorer soils, will greatly surpass that of the osage orange. For barrier effect, especially in separating cultivated fields from pastures, orchards, or in fencing out terrace outlets and the like, the plants in becoming established should be given good culture. This may consist chiefly of cultivation or mulching; and fertilization may be necessary for the first 2 to 3 years in order to grow a uniformly vigorous and dense barrier.

Tends to Prevent Spread of Vegetation.—Experimental and demonstration plantings show that the dense shade produced by the hedge tends to prevent the growth and spread of grasses and weeds that are extended in or above the soil through the development of stolons or runners. Bermuda grass is a good example. Stopping or checking Bermuda and similar plants is important because they may spread rapidly from pastures, terrace outlets, uncultivated areas, roadsides, etc., to cultivated fields.

Protect Plantings but Sprays May Not Be Needed.—Livestock may browse upon the tips of the tender rose branches and trample them down while they are young. This is likely when the plants are from 1 to 2 years old. Well established barriers have not been damaged materially by the feeding of livestock on leaves and branches, or by trampling and attempts to push through the hedge. The plants are also resistant to the attacks of fungus diseases and foliage eating insects. Thus far, therefore, spraying for pest control has not been needed.

EXPERIMENTAL PLANTING

In establishing the University of Missouri Midway Horticultural Farm Experimental planting, a distance of about one-fourth mile was used for the barrier. The site was prepared on a strip of land about 10 feet wide by back-furrowing and then bed-furrowing followed by disking. One year old rooted plants, produced from seed, were set in a furrow made on a slightly ridged strip in the center of the cultivated area. The plants were spaced about a foot apart on medium fertile, and well prepared topsoil. Following early spring planting the row of plants were cultivated three times at intervals of about two weeks. Mulching and fertilizing practices were omitted. Cultivation was employed the second year as it was during the first year. The average height of the plants after two full years of growth, was about 5 to 6 feet. The hedge growth was also dense and strong.

In the late summer following the second year of growth, the cultivated strips on both sides of the hedge were mulched with old hay to a depth of 4 to 5 inches. The mulch has prevented surface erosion and it has apparently conserved soil moisture. Additional culture or care has not been given or required. The hedge is now nine years old.

Effective Barrier Against Livestock and Poultry.—At the end of the second year of growth, a fence that had protected the plants was removed and the hedge row of the multiflora rose was made a part of the fence or enclosure to prevent damage to fruit trees and small fruits by livestock. It has now served effectively as a barrier against cattle and horses of various ages for 7 years. Although the plants were originally set 1 foot apart the growth is now so dense that it should also "turn" without difficulty hogs, sheep and even poultry. The fence is certain to stop poultry unless the birds are able to fly over a barrier about 8 feet high and 8 feet wide.

NURSERY STOCK

Sturdy one-year seedlings are usually considered best although two-year-old stock should prove satisfactory. The nursery stock may be produced

at comparatively low cost. Plants more than two years old are unnecessarily costly and seem to suffer considerably from the transplanting shock. Commercial nurserymen are now handling the rose plants. As yet, however, the supply of plants available from commercial concerns may not be equal to the demand.

PROPAGATION BY SEEDS.—The use of seed constitutes the most common method of propagation. Seed is harvested after full maturity in late October or early November. It may be planted at once in nursery rows laid out in well prepared soil. The rows are usually spaced about 3½ to 4 feet apart and the seeds are planted about 5 to 6 inches apart and covered with loose soil to a depth of about an inch. Stakes may mark the rows and permit cultivation early in the spring before seed sprouting occurs. After one good season of growth the plants may be suitable for setting in the fence row. However, if they are too small for handling, they may be allowed to grow another year.

PROPAGATION BY HARDWOOD CUTTINGS.—Portions of the dormant stems of the previous season's growth are cut 7 to 8 inches long during late fall or early winter. These are placed in moist sawdust or sand and stored at a temperature of about 45° F. Cuttings may also be taken before growth starts in late winter or early spring. Early in the spring as soon as weather and soil permit, the cuttings may be planted in a nursery row or direct to the fence row if they can be kept cultivated and irrigated the first year to insure a good stand of plants. If the callused tip of the stored cutting is moistened and dipped into the powder of any of the commercial plant root hormones successful rooting of the cutting may be materially aided.

The cuttings in nursery rows are spaced 3½ to 4 feet apart and in the row about 7 to 8 inches apart. The soil is firmed about the cuttings by tramping. About 2 inches only, of the top part of the cuttings, are allowed to remain above the soil.

SOFTWOOD CUTTING.—Softwood or green cuttings may also be made in June and early July. Treatment with a commercial root hormone as suggested for hardwood cuttings should prove very helpful in securing rapid and satisfactory growth. All the care and attention regarding preparation of cuttings, planting operation, cultivating and irrigating apply equally well to the growing of green or softwood cuttings.

After one season of growth, all the plants produced from cuttings may be lifted in late fall or early spring and transplanted to the permanent fence row or location. The plants are sometimes, however, allowed to grow another season in the nursery row before transplanting. Such two-year-old plants should also prove satisfactory if handled properly. After setting, all plants should be cut back to about 4 to 6 inches.

SOIL PREPARATION FOR PLANTING

A fall application of 2 to 4 inches of manure spread over the planting site should generally prove satisfactory. Also, the manure may be supplemented to advantage through the use of a complete fertilizer like 4-12-4. This product or a similar combination fertilizer may be placed on the

manure or mixed with it at the time of spreading at the rate of about 160 to 200 pounds for each $\frac{1}{4}$ mile of a strip 10 to 12 feet wide.

Thorough disking should follow the fertilizer application. Then plow the planting site as deeply as soil conditions permit leaving a slight ridge in the center of the cultivated belt to facilitate soil drainage. After the plants are established, if more growth is needed a side dressing or moderate application of a nitrogen fertilizer like ammonium nitrate, sulphate of ammonia or nitrate of soda may be used in the early spring. For some soil types a complete fertilizer such as 5-10-5 or some other combination may also prove satisfactory as a side dressing.

TRANSPLANTING FOR HEDGE FENCE

Rose multiflora is easy to transplant and gives remarkable survival *when transplanted in a dormant condition.* Growth begins unusually early in the spring and the plant suffers heavy shock when planted after the buds break. On the more porous soils toward the South best results have been secured from late fall planting with mulching. Early spring planting is better toward the North and on the tighter soils, unless a heavy application of mulch is used when late fall planted. Mulching after late fall or early winter planting is advisable to prevent the plants from being pushed up out of the soil as a result of alternate winter freezing and thawing.

Bundles of nursery stock upon arrival should be opened at once and the packing material, including the roots, wet down without delay. If soil and weather conditions permit, planting should go forward at once. Otherwise, heel-in properly and water thoroughly. Maintain the soil in a moist condition until planting. In the setting operation keep the roots in containers partly filled with water or cover them with a damp packing material. At no time should the bare roots be exposed to the drying action of the wind and sun even for a few minutes.

An efficient method in commercial planting consists of opening a furrow with a single-bottom plow in the center of the back furrow of the prepared planting strip. The plants are properly spaced in the furrow. The soil is then turned back into the furrow, and where a tractor is used, the soil may be packed or tamped by allowing the rear tractor wheel to run alongside the row and about $2\frac{1}{2}$ to 3 inches from the plants. The soil may also be firmed or packed about the plants by tramping. The soil must be firmed around the roots for good results.

Spacing and Planting Near Trees.—In the first experimental investigations the plants were spaced 3 or 4 feet apart for a single-row barrier. More recently plantings have been made with plants 1 foot apart to turn horses and cattle and 6 inches apart as a barrier against hogs, sheep and goats. This closer spacing seems much more certain of achieving results in terms of a tight barrier at the earliest possible date. Furthermore, the multiflora rose cannot be expected to make a dense, vigorous growth where overtopped by trees; hence barrier plantings around woodlots or trees should be at least 20 to 30 feet away from large trees for satisfactory growth.

Mulching, Cultivating and Fertilizing.—The multiflora rose responds markedly to liberal mulching (straw, spoiled hay, old stack butts, manure and sawdust). Cultivation the first year or two is likewise beneficial, but cultivation is not necessary where liberal mulching suppresses grass and weed competition. Mulching has generally proven to be more serviceable than cultivation, especially where there is danger of soil erosion on sloping land.

When the plants are set, a complete fertilizer such as 4-12-4 or 5-10-5 may be used. One pound for every 40 feet of row mixed thoroughly with the soil in the furrow where the plants are set should give good results. In the early spring of the following year, a side dressing, applied about 3 to 5 inches from the plants using ammonium nitrate or some other equivalent nitrogen fertilizer usually proves helpful. The fertilizer may be applied on top of the mulch or cultivated into the soil at the rate of about 1 pound for every 40 feet.

AN EFFECTIVE BARRIER BUT NO DANGER OF INJURING LIVESTOCK

Livestock of the various kinds are often injured seriously through contact with wire fences particularly. In as much as the living fence establishes a dense barrier, it excludes the view to a height of about 8 to 10 feet when in full foliage. Even in winter or during the dormant season the screen is almost perfect. There is less tendency, therefore, for livestock to attempt to penetrate the barrier. Also, there is no likelihood of serious injury through contact with the thorny plant.

The height, spread and thorny mass is about as difficult to scale or penetrate by man or beast as the most substantial structures used around various kinds of institutions including athletic grounds. The great number of uses to which the multiflora rose fence may be put makes it almost a so-called "natural" for use as an enclosure for tree, small fruit, and vegetable plantations.

SUMMARY OF ADVANTAGES

Rose fences may be grown in 2 years with good soil and culture.
The first investment is small and maintenance care lasts 2 to 3 years.
It is an excellent cover for wildlife and stops soil erosion.
It helps contour tillage and mends pasture gullies.
Weed control is facilitated and it stops Bermuda grass.
Aids insect control by harboring birds and small animals that feed on insects.
Has ornamental foliage and flowers; the seed may supply winter food for birds.
It is strong, dense and thorny and repels both man and beast.
Well suited for line, contour and irregular fencing.
Makes a long-lived barrier for 50 years or more.
Does not usually require spraying, clipping, pruning, training or support.

Serves as low windbreak to reduce wind and sand damage.
Can be sheared and trained to height and form desired.
Livestock are never injured or crippled in the fence but it is effective.
As difficult to scale as athletic and prison barriers.
Makes a good screen for summer and winter.
Burning may not kill but barrier may be impaired for 2 or 3 years.
Missing plants may be replaced by transplanting others.
Plants may be destroyed easily by lifting with a bulldozer.
There is no evidence to indicate that the multiflora rose hedge will ever become a plant pest.
The multiflora rose is hardy, dependable and rarely fails to please.
It is grown successfully in the deep South and far North. Where doubts exist, consult authorities or make trial plantings.

Chapter 4

Budding and Grafting Fruit Trees

PROPAGATION methods such as budding and grafting have been used by fruit growers since ancient times. In early periods some who practiced the art endeavored to shrowd it in mystery. Many were led to believe that one had to be endowed with special faculties to propagate fruits successfully. Now, however, budding and grafting of fruit trees is widely understood and the methods are so simple that anyone of average intelligence can perform the work successfully through a careful study of the methods combined with adequate practice.

MEANINGS OF PROPAGATION TERMS

STOCK.—That portion of the tree branch or root upon which the scion is grafted or budded is designated as the stock. With the completion of the operation of grafting or budding that part of the tree below the point of insertion of the scion or bud is known as the stock.

INTERMEDIATE STOCK.—This consists of a piece of trunk or the lower framework of a tree which has been introduced between the stock and the scion variety. The object or purpose may be for one or more reasons. Some of these are for increased or decreased vigor, hardiness, disease resistance, etc.

SCION (also CION).—Dormant wood of the previous season's growth when cut and used for grafting is known as scion wood.

CAMBIUM LAYER.—This is made up of a thin layer of cells between the bark and the sap wood. During the growing season cells are constantly dividing and forming new cells. When the bark is peeling readily in springtime the slippery substance on the sap wood and bark consists chiefly of cambium-like cells. In all grafting and budding work, the cambium layers of both stock and scion must match or come together at one or more points for growth to take place.

BUDS.—Buds suitable for the different types of propagation work may be taken before growth starts for dormant budding or after growth starts when the bark will peel and slip readily for spring and summer budding. The buds used are found at the base of each leaf stalk on current season's growth.

BUD STICK.—The shoot from which the buds are cut is called the bud stick. It is produced during the current season at the ends of branches. The bud stick is selected from the variety to be propagated. The leaves

are removed but a portion of the petiole or stem is left to serve as a handle for inserting the bud in the stock.

TOPWORKING.—The orchardists employes topworking to change the top of an immature or mature bearing tree to that of another variety. Either budding or grafting or both practices may be used in changing the tree top to the variety desired.

DOUBLEWORKING.—The process of doubleworking or doublegrafting fruit trees introduces between the root and top, a section or part of the

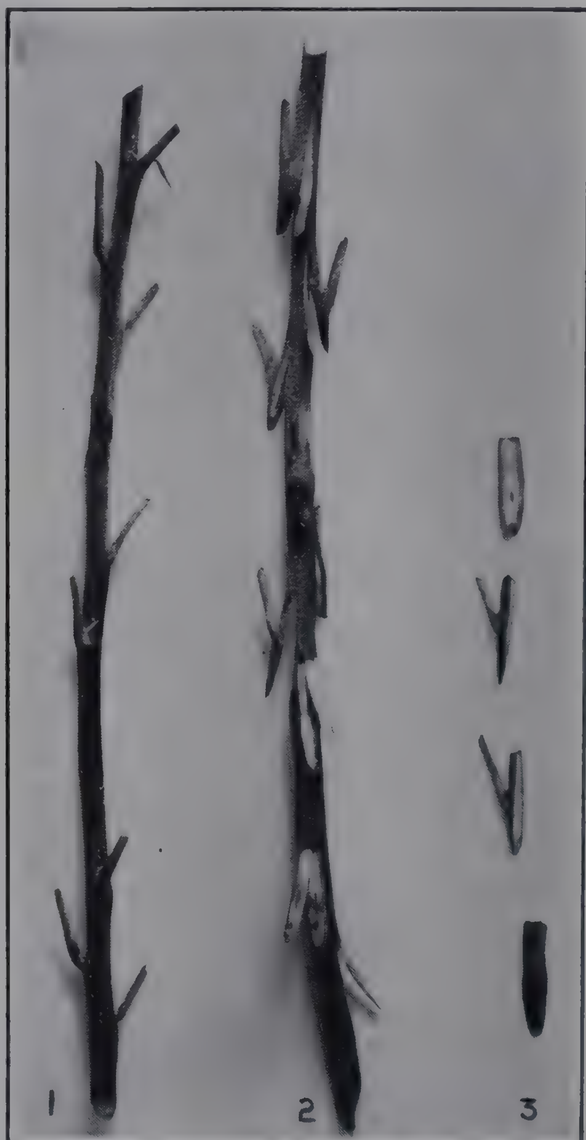

FIG. 9.—Apple bud sticks used in shield budding. (1) A portion of the petiole or leaf stem left to facilitate handling of the bud. (2) Methods of cutting and removing buds. (3) Buds in different positions after removal. (Mo. Agr. Exp. Sta.)

trunk of a tree. The reason for such doubleworking is to avoid many of the troubles affecting the trunks and crowns of the apple trees such as collar rot, fire blight and winter injury.

BRIDGE GRAFTING.—This is a method of repairing injury by means of grafting. The area injured is bridged by means of scions placed below and above the injury thus bridging or spanning it. The scions are placed between the bark and sap wood of the stock in such a manner as to promote

growth. Several scions may be introduced at specified intervals in bridging the injury.

SOME ESSENTIALS OF GRAFTING AND BUDDING

The scion and stock must be capable of uniting and developing a good union. Plants not closely related may only occasionally intergraft successfully. It is necessary, therefore, for good growth and development that the plants grafted or budded be closely related. In both grafting and budding the cambiums of both stock and scion should be in close smooth contact.

FIG. 10.—A hardy six-year-old Virginia Crabb apple tree topworked (grafted) to Starking Delicious. Strings have been tied around the branches to indicate the place where whip grafting occurred. The tree top above the strings is now beginning the fifth year of growth and the tree is starting its seventh year in the orchard. (Mo. Agr. Exp. Sta.)

Furthermore, it is essential for growth that the drying of the parts connected be prevented. Grafting wax is, therefore, usually applied and should cover all wounded surfaces. Follow-up work consisting of rewaxing and bracing the introduced scions and shoot growth may also facilitate good development. The operations must be done at the proper season of the year when bud and scion wood is of the right maturity for the manipulations performed to be successful in promoting satisfactory growth.

GROWING APPLE NURSERY STOCK FROM SEEDS

The natural method of propagating the apple is by means of apple seeds. The apple, however, like most of our cultivated fruits, does not come true from seeds. As many different varieties as there are seeds planted will generally be produced. Moreover, experience has shown that most seedling apple varieties are inferior to standard sorts and not often is there introduced a new seedling variety of merit. As a rule, seedlings are grown only as stocks upon which to bud or graft superior or cultivated kinds.

Seedling apple and pear roots used in this country for whip and tongue root grafting are often imported from France. In the United States, the Kaw River Valley just west of Kansas City is noted for its production of fine seedling apple roots used as stocks for named apple varieties. Seeds from our cultivated varieties like Jonathan, Ben Davis, and Winesap may be used. The so-called French crab apple seeds are generally used in growing apple seedling roots for grafting and budding.

Apple seeds may be procured by washing the pomace obtained at cider mills. However, considerably increased pressure may crush and destroy the seeds. Also, long standing of pomace in piles may lower seed germination. The method of procuring the seed may consist of placing the pomace in a barrel or other container and adding water. In 4 or 5 days some fermentation may have taken place and by stirring the pomace vigorously the seeds may be separated. The pomace will rise to the top of the container, while the viable seeds will settle to the bottom. The pomace and water are then poured off and the seeds are collected.

The seeds are dried for a few days in the open air, after which, they may be stratified in damp sand. In a flat wooden box of convenient size with good bottom drainage, is placed about 2 inches of damp sand, then a layer of seeds, and upon this, alternate layers of sand and seeds are placed until the box is filled or the work is complete. The stratified seeds should be kept moist and cool until time for planting in the early spring.

The box of seeds is sometimes buried in a well-drained soil to a depth of 6 to 8 inches or placed in a cool cellar until spring. It may also be placed flat on the ground and covered with strawy manure to a depth of about a foot in order to prevent severe alternate freezing and thawing. Since the seeds begin growth early in the spring, the soil in which they are to be planted should be prepared in the fall or early winter by deep plowing. It is important that the soil be deep and rich; otherwise it will be impossible to produce straight, long roots of the kind convenient and suitable for root grafting purposes.

The apple seeds are planted from 2 to 4 inches apart in rows about $3\frac{1}{2}$ to 4 feet apart and covered with soil to a depth of $\frac{1}{4}$ to $\frac{1}{2}$ inch. When the seedlings spring up they should be given very thorough cultivations during the growing season by plowing and hoeing. Supplementary irrigation may be important. In the fall after the leaves drop the little trees are dug, if large enough. When they are considered too small for use they may be allowed to grow another year before digging. For convenience in handling, the tops are shortened after digging and the trees are tied in bundles of

from 25 to 50 or more. They are then packed in boxes of green sawdust, damp sand or other damp packing material and stored in a cool place. The seedling roots are used extensively for whip grafting in January and February. They are known as apple "stock" and are used in the propagation of named varieties of apples. In general, pear seeds may be handled like apple seeds in producing propagation stocks.

WHIP GRAFTING FOR BOTH NURSERY AND TOPWORKING PRACTICES

Root and Scion Grafting.—This method of grafting is frequently referred to as "whip and tongue grafting" or "root grafting," as the method employed usually has to do with grafting a scion upon a root. The whip and tongue graft is used in grafting the roots of seedling apple trees from one to two years old and $\frac{1}{2}$ to $\frac{5}{8}$ inches in diameter upon scions (current season's growth, about the size of a lead pencil). The seedling roots and scions are usually removed from cool or cold storage and grafted during January or February. A cellar or basement room is generally used for this purpose, but a drier and warmer room may be used if the scions and roots are kept in their original packages and covered except when in use. Scions, roots or grafts should never be allowed to dry out. The roots may be from 14 to 18 inches long, and for grafting purposes they are frequently cut into pieces from 3 to 6 inches long, the average being about 4 inches. Each seedling root, therefore, may make from two to three grafts.

Methods Adaptable to Root Grafting or Topworking.—In making the graft, a sloping cut about $1\frac{1}{2}$ inches long is made on one side of the upper end of the seedling root. The same kind of sloping cut is made on the lower end of the scion. The knife is then placed on the sloping cut at a distance of about $\frac{1}{2}$ or $\frac{1}{3}$ inch from the end and a tongue is cut here on both scion and root. They are then pushed together, the tongues of each slipping into the slits made for them. To complete the graft, the scion and root are wrapped fairly tight with No. 18 or 20 knitting thread. Before tying the union or graft, however, it is important to see that the inner bark of both comes together at least on one side; otherwise, the graft is not likely to grow. Commercial nurserymen use machines for wrapping grafts. If the scion and stock are of different diameters, care must be taken to insure the proper interlapping of the edges, at least on one side. Poor unions invite crown gall or root knot and other troubles. The weak cotton string with which the stock and scion are wrapped will decay rapidly and cause no injury when the grafts are set in the soil. The finished graft, including the scion and root, should be about $8\frac{1}{2}$ to 9 inches long. The scion whether for root grafting or topworking is usually about 4 to $4\frac{1}{2}$ inches long.

STORING, PLANTING AND CULTIVATING GRAFTS

The grafts may be packed in bundles of 50 to 100 each and stored in damp sand or green sawdust and placed in cold storage, a cool cellar or a callus pit until they are set in the nursery row in the early spring. The

soil for planting should be plowed in the fall in order that the grafts may be planted as early as possible. Prepare the ground as for a garden. The grafts may be planted either in holes made by a "dibble" or along the smooth straight edge of a furrow made by a plow. In either case, it is important to leave only the top bud of the scion above ground and to pack the soil tightly and firmly around the base of the graft.

If the young trees receive frequent shallow cultivation throughout the spring and summer, they should grow to a height of $2\frac{1}{2}$ to 3 feet or more, when they are considered large enough for transplanting as "one-year-olds" any time during the late fall, early winter or the following spring. They may also be dug and stored in moist sand or green sawdust like scions or seedling apple roots. If the trees are not large enough in the fall for transplanting or if there is no ready use for them, they may be left undisturbed in the nursery. The trees may be grown in the nursery row for another year and used or transplanted as 2-year-old trees, or they may be cut back in the early spring to the original bud near the ground or just above the union of stock and scion. This usually causes a quick, vigorous growth of one or more shoots. The best shoot is selected and grown as a long straight whip. Others are promptly removed. At the end of the growing season it is called a "cut-back" with a 2-year-old root and a 1-year-old top.

GROWING PEACH, CHERRY AND PLUM NURSERY STOCK

The seeds of about average size free from cracks and splits are selected. Some varieties produce more suitable seed for propagation than other sorts. They are collected in late summer and early fall soon after fruit harvest. In September or October on deep, fertile, well prepared soils the plantings may be made. The rows are spaced from $3\frac{1}{2}$ to 4 feet apart and the seeds are dropped or placed in the row at distances of about 6 to 8 inches apart. For large plantings, machines similar to corn planters are used for opening the furrows, dropping the seeds and covering them with soil. In general the best depth of planting for loose friable soils containing ample quantities of organic matter is about $1\frac{1}{2}$ to 2 inches. The seeds are sometimes planted 4 to 5 inches deep in the fall or early winter. Early in the spring, as growth is starting a part of the soil is removed leaving the seeds about $1\frac{1}{2}$ to 2 inches beneath the soil.

Furthermore, the seeds in some sections are held over for the winter in cold storage, cool cellars or outdoor pits and planted in early spring. This may be particularly true toward the North. It is not necessary for the seeds to be subjected to alternate freezing and thawing before germination as formerly believed.

For the production of strong growthy seedlings, timely and thorough cultivations should follow plantings at intervals of about 12 to 14 days. It is important that plowing and hoeing should be frequent enough to keep down the growth of grass and weeds. Also, it should be continued until about the middle of July or first of August. The time of stopping cultivation practices will vary in the different sections and the amount will depend upon the need. Usually no more stirring the soil than needed to control weed growth will prove profitable.

SHIELD BUDDING OF STONE FRUIT SEEDLING NURSERY STOCK

Shield budding is usually done any time from the latter part of July until about the middle of September. However, the time usually best suited for the work is during late July and August. The method is the same, summer or fall and may be used for propagating nursery stock and for topworking hardy stocks. The bark must be loose and easy to peel if the operation is to be rapid and successful. Budding is especially suitable for the stone fruits such as peaches, cherries and plums.

FIG. 11.—T-budding. (A) Budding stick showing method of removing the bud with a short piece of the leaf petiole attached as a handle. (B) T-cut through bark. (C) Bark raised to admit bud. (D) Bud in place. (E) Bud wrapped in raffia. (From U. S. Dept. of Agr., Farmers' Bulletin, 1567, 1932.)

SELECTING BUDS.—A bud stick or twig of the current season's growth having several buds is selected from the variety that is to be propagated. This is done just prior to its use. The leaves are removed, leaving a portion of the petiole to serve as a handle in inserting the bud. Bud wood may be kept for several days in cool moist storage.

DOING THE BUDDING WORK. A T-shaped cut is made preferably on the north side of the seedling tree as close to the ground as convenient in performing the operation. The north side is suggested because reduced sunlight may strike this side and less drying occurs. On the budding stick the knife is inserted about $\frac{3}{8}$ inch below the base of a bud and moved upward about $\frac{1}{2}$ inch above the bud. A shield-shaped piece of bark is cut away from the budding stick, including a bud in its center. The sides of

the bud are grasped between the thumb and the first finger. Pressure is applied. In so doing the bark springs or slips away from the wood leaving the bud without wood. If the bud is cut thick, it is well to spring the wood loose by pressure from both sides of the shield and remove it as suggested. However, when the shield is cut fairly broad but thin and with a minimum amount of wood, the extra step of wood removal is unnecessary.

The bud with attached bark or wood is inserted in the T-cut by carefully raising the bark from the wood slightly and pushing the rounded end of the bud downward until it fits squarely and smoothly against the wood beneath the incision of the bark. After the bud is inserted the flaps of bark are tied in place with raffia or cotton twine or held in place by a rubber band. Rubber strips used without strong tightening need not be cut. The bud piece must be held securely against the cambium of the stock. In about ten days or two weeks when the bud has grown tight, the string or raffia is cut on the opposite side from the bud, to prevent girdling. Where rubber bands are used, cutting is not required.

When the bark doesn't slip readily on the bud stick, a somewhat thinner sliver of bark and wood including a bud is removed. This is inserted on the stock as described above without removing the piece of wood under the bark and below the bud. In all instances the bark must slip readily on the stock for satisfactory results. The parts must be prevented from drying out during the operation.

The inserted bud remains dormant until spring if the work is done after the month of June. Enough growth occurs, however, for the bud to become firmly united with adjoining parts. As growth begins in early spring, the top of the stock is removed just above the bud, and the sprouts which may arise below the bud on the stem are carefully removed several times if needed during the growing season to stimulate and force the inserted bud into active growth.

Most of the stone fruits are propagated in this manner. They respond better to budding than grafting practices. The pome fruits (apples, pears and quinces) may be propagated by either grafting or budding. If such trees are growthy and healthy, there should be little or no material difference between budded and grafted trees in their use by the orchardist.

June Budding.—Shield budding may be done in late May or early June. Then the process is known as "June budding." The buds may be set after a few days if they are going to grow. The tops are then promptly removed just above the inserted bud. By the end of the growing season the top growth from the inserted bud may be a foot or more in length.

Waxing.—In general, waxing is not needed. The application of wax, however, to all cut surfaces may tend to prevent desiccation and thus make the budding practice more successful. For the amateur and where only a few buds are placed, waxing may facilitate growth.

Other Kinds of Budding.—The principal kinds of budding may be named according to the various methods of doing the work. Moreover, they apply more to topworking nut trees than to fruit trees. In addition to shield budding, described above, there are twig or spur budding; flute, patch or veneer budding; plate budding; ring or annular budding; and still other kinds. Shield budding for all purposes is a great deal more important

and much more common than the other kinds of budding. In fact, the other methods are not used except in cases where shield budding does not give satisfaction.

USE OF HARDY APPLE STOCKS

Observations and studies of the Agricultural Experiment Stations have indicated a need especially in North and Central States for the use of hardy intermediate apple stocks. Many of our so-called standard varieties often show unmistakable evidence of winter injury at the base of the tree trunks and in the crotches of scaffold branches. These parts mature latest in the fall and are usually most susceptible to injury by cold weather. It is now known that much of such damage may be prevented by substituting hardy, early maturing tree bases and crotch angles for those of the common varieties which are more likely to be damaged. Upon the strong, hardy lower branch and trunk framework, the less hardy varieties of apples are budded and grafted.

DESIRABLE HARDY VARIETIES

The hardy varieties known as Hibernal and Virginia Crab have been more widely used than others for top-grafting and budding. Data also shows that early production of most varieties on Virginia Crab is greater than on Hibernal.

For most conditions, experience has shown that both Rome Beauty and Jonathan should be budded or grafted on Virginia Crab. On the other hand, it appears that Mammoth Black Twig and Stayman give better results when grafted on Hibernal stocks. Grimes, Delicious and the Delicious Red sports produce equally well on Virginia Crab or Hibernal. Although careful production records are not available, practically all the other commercial varieties grown in the midwest are productive upon both Hibernal and Virginia Crab stocks.

THE TECHNIQUES OF TOPWORKING TO PREVENT COLD INJURY

Budding and grafting are specialized horticultural practices. They require for their successful use detailed information. The suggestions which follow, therefore, are designed to give the knowledge needed. When a good working knowledge is secured and supplemented by a sufficient amount of practice, worthy accomplishments may be made.

The usual plan or procedure is to plant root and scion grafted trees of the hardy varieties selected and grow them from one to two or more years in the orchard location. When a satisfactory framework consisting of trunk and 3 to 5 scaffold branches have been developed, the trees are ready for topworking. The selected main branches are budded and grafted at a distance of 12 to 18 inches from the central stem to the variety or varieties desired.

Just before or just as growth is starting in the spring the small scaffold or main branches may be whip grafted and the large ones cleft grafted.

Also, shield budding in the following summer may be used in late July, August and early September on branches, if any, where the grafted scions failed for any reason to grow.

Fortunately, most of the hardy stocks have wide-angled branch crotches, which are not susceptible to splitting down nor to injury by winter cold. It is important that this type of branch framework be retained. All sprouts or shoots arising from the main stem and below the budding or grafting union on the branches should be removed promptly. On young orchard trees, the leader and every scaffold branch should be grafted or budded at the same time. In so doing not more than two years should be required for the completion of the topworking procedure.

FIG. 12.—Root, tongue, or whip grafting. (A) Stock and scion prepared. (B) Stock and scion fitted together with slits or tongues interlocking. The scion has been placed to one side to secure proper cambial contact. (C) Graft is completed, tied securely with No. 20 knitting thread which does not require cutting. It is ready for planting or storage. (From U. S. Dept. of Agr., Farmers' Bulletin, 1567, 1932.)

Topworking Methods

The three methods of top-working the hardy stocks are fully described and explained in detail as follows:—(1) *Whip and Tongue Grafting Method*

described on page 43 may be easily adapted and used effectively in grafting the tops including the scaffold branches to the desired varieties. (2) *The Shield Budding Method* is likewise fully described in detail on pages 45–47. It is equally well suited and adapted to the top-working of the branches of hardy stocks and may be practiced generally from June until September. (3) *The Cleft Graft Method* with complete suggestions follows and may in some instances as noted be used to advantage in top-working hardy stocks.

How to Topwork Hardy Stocks by Cleft Grafting

Cleft grafting work is generally most successful when done just before or just after growth starts in the spring. If there is a great deal of work to do, the grower may start two or three weeks before the buds swell. Dormant scions should be used and they should be cut from well matured, dormant wood of the current season's growth during the fall or winter and placed in cold storage or in a cool place in damp sand or sawdust. All of the branches to be topworked that are more than ½ inch in diameter may usually be cleft grafted with greater likelihood of good unions than by the whip graft method.

Preparing the Stock.—In cleft grafting, the operation consists in sawing off the stem or branch some 12 to 18 inches from the trunk as in whip grafting. The stump if required is split with a heavy knife and maul. The cleft or split should be made about 2 or 3 inches deep. The knife is then removed and placed in the center of the cleft in order to spread it for receiving the scions. Two wedge-shaped scions about 4 to 5 inches long may be used, one in each side of the split. It is always well to use two scions, depending on the size of the stock, as scions are frequently broken out by the wind and other factors. If the stump is large and there is danger of the pressure crushing the scions, a wedge may be driven down into the middle of the split to hold the parts of the stem or trunk open and lessen the pressure upon the scions. The top of the wedge is then cut off level with the stump.

Preparing and Inserting the Scions. The scions should be placed so that the inner bark of one side makes an exact union with the cambium or inner bark of the stock. This is very important, as it is at this point only that any growth occurs. The scions, containing from 3 to 5 buds each, about 4 or 5 inches long and about the size of a lead pencil, are prepared by making long, sloping cuts from 1½ to 2 inches in length on both sides of the lower ends. The wedge-shaped scions are then ready for insertion in the split or cavity made in the stock. Where the scion and stock are approximately the same size, the whip and tongue graft may be used more successfully than the cleft graft.

Waxing and Subsequent Treatment.—After the scions are in place they may be tied in with waxed tape or string. All wounded surfaces including the top of the scions should be thoroughly and completely covered with grafting wax. If the wax is hot, 2 or 3 coats may be required. The clefts must be closely sealed to keep out air and disease and to prevent the wounds from "bleeding." The wax should never be disturbed and new

applications, if needed, should be made one or more times each growing season until the scions are well established and the wounds are healed.

After 5 or 6 weeks, when growth should be well started, the tape or cord around the top of the stock to hold the scions in place should be cut with one stroke of a sharp knife; otherwise, if it be very strong, it is likely to girdle the stock. In all the operations, including the follow-up work such as pruning, the form or shape of the tree top characteristic of the variety should be maintained as nearly as possible. This will require, after the scions are firmly established, the removal of all but one per branch.

Cutting and Using Scions in Spring

Scions may be cut and used successfully early in the spring immediately before or as growth starts. However, the timing and proper handling must be right because dormant scions generally grow much more rapidly and give better results than those that have started perceptibly into growth. In general, the more growthy the scions at time of use the less likely they are to grow. Where there is a comparatively small amount of grafting work to do, it is possible through the use of good judgment and care to secure satisfactory growths from scions cut and used promptly at the usual time for grafting in early spring.

Selecting Scion Wood and Its Care

Scion wood should be carefully selected and labeled. Nearly all of it is cut some time during the fall or winter from unfrozen, well matured wood of the last season's growth. One-year-old wood is preferred because experience has shown that its buds are more likely to grow successfully upon the stock than the buds from wood two or more years of age. Scions from bearing trees assure trueness-to-name. However, wood from young trees true to name may be equally as good. The length of the scion wood will depend upon the amount of growth during the past season. This may range from 10 to 12 inches to 20 inches or more. Scion wood should not be cut too long for convenience in handling and storing. When taken from frozen wood or from wood which has been injured by diseases or low temperature it may prove worthless.

Scions and buds should be kept moist and damp. Buds beginning growth or that have become shriveled by drying are much less likely to grow. Suitable conditions may be provided by storing in clean damp sand or green sawdust or by placing in a cool cellar or cold storage. A temperature of about 35 to 40° F. is best. When scions are kept in a room which is too warm they may start growth and be unfit for use; while if kept too wet they may rot or be severely injured.

Stratification of Scion Wood

Scion wood is stratified by packing with sand in a flat box or other container having good bottom drainage. They are tied in bunches, labeled and placed upon layers of moist sand about 1½ inches in depth. Alter-

nate layers of the sand and scions are made until the box is filled or the work is finished. The box may then be stored in a cool cellar or outdoors in a well-drained soil located on the north side of a building or hedge and mounded with soil to a depth of 6 to 8 inches. A mulch of 2 to 3 inches of straw or other litter during the winter may be helpful. As both high and low temperatures may retard later growth, the more nearly the temperature can be kept at about 40° F. the better for good results.

Summary for Scion Wood Selection and Care

(1) Scion wood which shows browning of the tissues resulting from winter cold or other causes should be discarded; (2) likewise those which exhibit shriveling due to drying are of little or no value; (3) tips of branches formed late in the previous season that have poorly developed buds and show soft, immature wood are unsatisfactory; (4) the base of vigorous shoots are likely to have buds that will make a slow and weak growth; and (5) keep moist and cool when cutting and using and store promptly and properly.

LIMITS OF GRAFTAGE

Propagators have generally limited graftage (budding and grafting) to plants which have a continuous growing layer (cambium) beneath the bark layer, because successful graftage depends upon the rapid growth and union of the growing layers beneath the bark of both stock and scion.

Fruits botanically related like the apple, pear and quince can usually be intergrafted or budded successfully. The process is still easier between varieties of the same species as apple upon apple. The peach is frequently budded upon the plum and likewise the plum upon the peach. In most cases the stone fruits may be interbudded and grafted without difficulty, although in some instances it is not practical, as the growth is uncertain, slow, and the union between stock and scion is poor.

Chapter 5

Culture of Apples, Pears, and Quinces

In as much as apples are now much more important in both the home and on the markets throughout the country than pears or quinces, this chapter will be devoted almost entirely to apples. It must be stated, however, that a major portion of the discussions dealing with the fruit may be applied equally well to the growing and handling of pears and quinces which are closely related fruits.

All together, the apple, pear and quince constitute the pomes or pomaceous fruits. The kinds of pome fruits listed other than apples and pears, are of minor importance as they are rarely produced except for special purposes as specimen plantings in parks, public gardens and collection plantings.

ORCHARD LOCATIONS AND SITES

The location has to do with the relative distance from town, city, home, highway or some other established place. Sites in contrast refer to elevation, topography, bodies of water and other factors that may effect the growth and fruiting of the trees. A poor location or site is certain to be an enduring handicap while good ones are generally considered a great asset as they enable the grower to more nearly attain his goal.

Some of the Problems to be Handled.—(1) How does the soil rank in fertility? (2) What is the character of the soil and subsoil? (3) Is the surface of the land smooth enough for the operation of orchard machinery including power equipment? (4) What is the state of the soil humus supply? (5) Is the location accessible without the expenditure of funds for improvements? (6) Has soil erosion been severe, moderate, or light? (7) Does the elevation, slope of ground and freedom from obstructions such as timber give the site adequate air drainage to help prevent cold injury? (8) Is the water drainage from the soil and soil aeration satisfactory for good root growth?

Orchard Site Selection.—Sites on fair to good cropping soils, where the elevation is sufficient to allow a free flow of cold air from the orchard land to streams and rivers may be favorable in preventing frost damage. On the other hand, sites selected on the tops of ridges or elsewhere that may expose trees to very strong winds are apt to prove unsatisfactory. Such sites are often difficult to reach and the soil fertility is likely to be low. If the slopes on the sides of the ridge are not too steep they may be

better suited to plantings. It is obvious that steep slopes increase the cost of operations but some such locations may be used if other factors are favorable. Soil erosion and its prevention may be serious problems on steep lands.

In a study of the soil, good drainage and aeration are of great importance. Orchard trees will not succeed on soils that may become water-logged during rainy periods. The texture and depth of the soil should be retentive enough of soil moisture to promote satisfactory root growth. It is just as important that it have capacity to absorb rain or irrigation water readily. Soils that have grown good truck and grain crops or forest trees are generally satisfactory for fruit tree crops.

When to Plant.—A summary of the findings and an extensive review of the literature indicates that spring planting is based upon experience in the more severe climates, while fall planting suggestions follow experience and observations made under conditions where milder temperatures are found. It appears, therefore, that spring planting is generally practiced north of a line passing from west to east through North Central Kansas, Central Missouri, and South Central Illinois, Indiana and Ohio. Similarly for the latitude south of this imaginary line, it is believed that fall plantings usually have the preference. For the other states and sections, planting in the spring toward the north where the climate tends to be severe and toward the south where the winter cold is less likely to cause injury, fall planting is generally practiced.

In the medial or border areas both fall and spring plantings may be successful. Under such conditions it is rarely if ever advisable for the grower to wait a year to plant in the fall or spring as proper planting at either season should prove satisfactory. For the southern milder sections, where the temperature may not fall below 0° F., trees may be planted any time during the fall, winter, or early spring when the ground is not frozen. The planter should know, however, that roots are more tender than the tops and are likely to be severely injured or killed by temperatures of 20° F. In fact, both grower and nurseryman should keep this information in mind. Also, soil and weather conditions should be suitable for planting.

YOUNG ORCHARD BEST

In most sections, the average life of an apple orchard is about 40 years. Of course there are exceptions and some orchards on good soils and sites with proper care may continue to be profitable for 50 to 60 years or more. However, other plantings are often through and should be removed at 25 years of age or less.

The good producer that is looking ahead will plan to have a young orchard coming along that will begin bearing when the old orchard is from 20 to 35 years old. This is true because he knows that apples of better size and color, and that show less injury from insects and diseases may be grown on young trees. The cost of orchard operations for the young planting is also less.

Replanting the Old Orchard.—It is possible in some districts for orchardists to procure satisfactory results in removing old trees by replant-

ing with young trees when old ones die or become unprofitable. For good results with this plan the young trees must be given special attention and the best of care. This may consist of mulching the soil around the tree with straw or other litter to a depth sufficient to keep down weed and grass growth. The young trees will also require fertilization, proper pruning and spraying as well as protection against damage by rodents. As replants they require extra supervision and culture.

Some apple growers may contend that old trees with replants never pays. Nevertheless, there are plenty of successful demonstrations in practically all orchard areas to demonstrate that through the use of wise and economical methods the practice has merit.

The chief difficulties with replants especially in old closely planted orchards is shade from the old trees and their root penetration into the feeding area of the replanted trees. Where the old trees were planted closely, some of their branches opposite the young trees may be cut back or removed. It is generally well to remove all of the remaining old trees when most of the replants are from about 5 to 7 years old. Also, it is generally better when young trees are planted in blocks soon after the removal of the old ones, to place them in the spaces between the rows rather than where the old trees stood.

AGE OF BEARING AND GROWTH

Some varieties of apples may come into noticeable production in about 6 to 8 years. However, in most orchards paying crops may not be produced until the trees are 8 to 10 or more years old. Generally it is advisable for the orchardist to push the trees along in growth and development as rapidly as possible in the early years. In fact, the first 4 to 6 years particularly should be designated as the growing and formative period.

Fire Blight and Cold Injury.—In a good growing young apple orchard perhaps the two most important factors to guard against are fire blight and winter cold injury. Both maladies may be more likely to occur with vigorous, growthy young trees. Should fire blight become too serious, slow up the tree growth by omitting the application of fertilizers, reduce cultivation and practice less severe pruning. These same procedures will help in preventing cold injury which is usually found at the base of the tree trunks and in the crotches of the large and lower branches. The purpose is to procure early, instead of late season growth. The sowing of a cover crop in late summer, or allowing weeds and grass to grow may slow down growth and tend to develop tree hardiness before cold weather occurs. For further information on cold injury consult Chapter 13.

IMMATURE NURSERY TREES

It is common knowledge that young deciduous fruit trees are often stripped of their leaves in late summer or early fall, removed from the soil of the nursery row and prepared for the early fall shipments. Nursery stock subjected to such treatment whether apple, pear, quince or some

other kind may make a poor or weak growth during the first two or three years after planting. Such weak trees may be susceptible to winter cold injury following late fall planting. They may also be made more susceptible to the attack of insects and diseases.

Stripping young trees of their leaves and digging in late summer or early fall does not allow the trees to fully reabsorb the manufactured food materials in the leaves. The foliage should be carried until the natural drop late in the fall or early winter when it cannot function further in developing hardiness. When growers demand fully matured and dormant trees for fall and early winter planting they are very apt to obtain them.

BETTER APPLE VARIETIES POSSIBLE

It is believed that the apple breeding programs of the State Agricultural Experiment Stations and the U.S.D.A. will in a reasonable period of time improve the present high quality of varieties by: (1) increasing substantially their vitamin C content; (2) adding the spritely flavor of the superior English sorts; (3) combining the delicate after-processing flesh texture and quality common to some of the better New Zealand and German varieties.

These assurances have been made possible through the extensive collections of foreign varieties at the research laboratories mentioned above. Also, promising hardy apple interstocks have been provided. These should prove of value in the northern United States and Canada where tree trunks and large limb crotches may be injured by low winter temperature.

Hardy stocks budded and grafted to standard varieties are now used extensively where cold winters prevail. It is also true that some varieties live longer and fruit more abundantly when top-worked on hardy stocks.

VARIETIES TO PLANT

Experienced fruit growers and Agriculture Experiment Station workers are in general agreement that on the varieties planted may hinge the success of the orchard project. It is not a matter of selecting the kinds or sorts that the grower prefers. Rather it is the varieties that may be grown successfully in the area and that meet the market demands which should be planted.

Fewer varieties are now planted in commercial orchards. In fact, from 3 to 5 sorts that will supply summer, fall, and winter markets may be sufficient. For roadside stands and local markets, some producers may require as many as 5 to 7 varieties in the planting. Rarely, however, will more kinds be needed and in most cases from 3 to 5 varieties are likely to meet the needs better than a larger number.

The lists of apple, pear and quince varieties to plant for summer, fall and winter production in the various growing sections of the country are likely to vary markedly due chiefly to climatic conditions, soil variations and consumer preference. Since the varieties we plant are so important the producer cannot afford to take a chance or give the question of varieties

minor consideration. Even a thorough and careful study supplemented by the best suggestions obtainable may not be entirely adequate for a complete solution of the variety question.

However, the experiences and observations of successful producers in the area coupled with the recommendations and suggestions of the State Agriculture Experiment Station employees should give the planter confidence and assurance. True it is, such authorities may make mistakes, but it should be remembered that rarely if ever, do they have any purpose other than to serve those desirous of information and assistance.

APPLE VARIETIES FOR GOVERNMENT PURCHASE, 1949

At conferences held simultaneously on October 3, 1949 in Portland Oregon, Chicago Illinois, and Washington, D. C., a list of 17 varieties were selected for purchase. The apples were required to grade United States No. 1 or State Fancy, or better. The list of varieties and sizes follow:

$2\frac{1}{4}$ *Inches up*
175's and larger

Jonathan	McIntosh
Winesap	Grimes Golden
Newton-Pippin	Golden Delicious
Delicious	Stayman

$2\frac{1}{2}$ *Inches up*
175's and larger

Cortland	Ortley
Rome Beauty	Northern Spy
R. I. Greening	Black Twig
York	Snow
Baldwin	

Perhaps, for the season of the year, October, these 17 varieties represent the chief sorts that are being grown today in the United States for commercial purposes. At least, it is worthy of comment to note that these varieties are still being produced in commercial quantities. Furthermore, it is obvious that for the different apple growing sections of the country, these varieties would not have persisted so long without the possession of meritorious factors or qualities. These sorts are still being grown in quantity or on a commercial scale, otherwise they would not have been designated for purchase. It is believed, therefore, that this is proof or evidence that apple growers may still consider such varieties in the list for planting, providing they continue to meet growing conditions and market demands in the districts concerned.

Arrange Varieties for Pollination.—As all varieties of apples may fail to set fruit with their own pollen, mixed variety plantings including good pollination sorts are needed. Very little pollen is produced by some

varieties of apples and much of it that is available may be of no value in securing a fruit set on its own flowers or on those of other varieties. This is especially true of the Winesap Group which includes Winesap, Stayman, Black Twig and others. Most of the other standard varieties grown in the different districts if properly arranged should serve as satisfactory pollinizers.

For the varieties to be effective as pollinizers they should all bloom at approximately the same period. Their arrangement in blocks of from two to three rows each and alternated from one side of the planting to the other is suggested. For example, plant two rows of Jonathan, then two rows of Winesap and again two rows of Jonathan or some other standard sort. The pollen of tree fruits being of a sticky and waxy nature is not carried or scattered to any considerable extent by winds.

HONEYBEE NEEDED.—The honeybee in its quest for nectar is the insect that is chiefly responsible for carrying and disseminating the pollen grains from blossom to blossom. This insect is the only one over which man has control and that may be present in sufficient numbers at blooming time to help materially in cross-pollination work. In cool, cloudy and rainy weather at the fruit blooming period, one good strong colony of bees may be required for each acre of mature orchard. With young trees just coming into bearing one colony for each two acres may be sufficient. For best results the colonies of honeybees should be distributed properly over the orchard and kept there from the start of blooming until after the height of the full blooming period. During warm, sunny weather much fewer bees are needed for proper pollination and a good fruit set.

LAYING OUT THE ORCHARD

At this stage of planning for the young orchard such questions as these may arise:

(1) Should terraces be constructed on the contour and the trees planted on them?

(2) Would it be better to set the trees on the contour without terracing?

(3) Is the land suitable for planting on the so-called square and rectangular plans?

TERRACE PLANTING.—No matter what the decisions may be regarding the questions listed above the chief objective is soil erosion prevention and the conservation of soil moisture as economical and effective as possible. With the establishment of terraces on the contour or with all the trees in a row planted at about the same level, the conservation of both water and soil is usually considered most satisfactory. The site is terraced by throwing up contour ridges, and the trees are usually planted on the tops of the ridges. The objections to terraces, however, may outweigh their advantages. Two of the most important drawbacks are erection expense, maintenance and difficulty of crossing the terraces from one tree row to another as all travel and orchard operations may be confined to the middles between the terraces. It is generally known that the preparation of fairly low and broad terraces may lessen materially the disadvantages mentioned and also be sufficiently retentive of moisture.

Important Characteristics of Leading Apple Varieties[1]

Variety	*Approximate Days After Full Bloom to Picking Maturity*	*Shape of Tree*	*Vigor of Tree*	*Ultimate Size of Tree*	*Age to First Bearing*	*Tendency to Annual or Biennial Production*
Yellow Transparent	70 to 75	Upright	Medium	Med. to small	Early (4 to 6 yrs.)	Biennial
Oldenburg (Duchess)	90 to 95	Spreading	do	Medium	do	Intermediate
Gravenstein	110 to 115	Upright spreading	Vigorous	Med. to large	Medium (6 to 8 yrs.)	Annual
Winter Banana	120 to 125	Spreading	Medium	Medium	Early (4 to 6 yrs.)	Intermediate
Wealthy	120 to 125	Upright spreading	do	Med. to small	do	Biennial
Cortland	125 to 130	Spreading	do	Medium	do	Annual
McIntosh	125 to 130	do	Vigorous	Large	do	do
Rhode Island Greening	135 to 145	do	do	Med. to large	Medium (6 to 8 yrs.)	Intermediate
Wagener	135 to 145	Very upright	Medium	Medium	Early (4 to 6 yrs.)	do
Stark	140 to 150	Upright spreading	Vigorous	Large	Medium (6 to 8 yrs.)	do
Golden Delicious	140 to 145	Spreading	Medium	Medium	Early (4 to 6 yrs.)	do

Grimes Golden	140 to 145	do	do	Med. to large	Medium (6 to 8 yrs.)	do
Baldwin	140 to 150	Upright spreading	Very vig.	Large	Med. to rather late (8 to 10 ys.)	Biennial
Jonathan	140 to 145	do	Vigorous	do	Early (4 to 6 yrs.)	Annual
Delicious	140 to 150	do	do	do	Medium (5 to 8 yrs.)	Intermediate
Esopus Spitzenburg	145 to 150	Upright	do	do	Medium (6 to 8 yrs.)	do
Northern Spy	145 to 155	do	Medium	Med. to large	Very late (10 to 14 yrs.)	do
Ben Davis	150 to 155	Upright spreading	do	Medium	Early (4 to 6 yrs.)	Annual
York Imperial	155 to 165	do	Vigorous	Large	Medium (6 to 8 yrs.)	Biennial
Rome Beauty	160 to 165	Spreading	Medium	Med. to small	Early (4 to 6 yrs.)	Annual
Yellow Newtown	160 to 165	Upright spreading	do	Medium	Medium to late (8 to 10 yrs.)	Biennial
Stayman Winesap	160 to 165	Spreading	Vigorous	Large	Early (4 to 6 yrs.)	Annual
Winesap	160 to 170	do	Medium	Medium	Medium (6 to 8 yrs.)	Intermediate
Arkansas (Black Twig)	165 to 170	Upright spreading	Vigorous	Large	Medium to late (8 to 10 years)	Biennial

[1] From Apple varieties and important producing sections in the United States. U. S. Dept. Agr. Farmers' Bull. 1883, 1941, by J. R. Magness.

Planting on Contour Without Terraces.—Where cultivation is to be practiced in starting the orchard and where erosion is likely to be a factor on sloping ground, planting the trees on the contour is generally considered a good procedure. It is necessary in laying out the tree rows to make it possible to plant all the trees in a row at about the same elevation. In so doing the rows of trees curve around the slopes and are maintained at an approximate level for the trees of any row.

Fig. 13.—Slight mounding of soil in tree rows to provide drainage for young apple trees and good trashy cultivation. (Mo. Agr. Exp. Sta.)

Cultivation around the curve tends to build up slight ridges along the rows that serve to prevent soil washing down the slope and increase water absorption. In a few years low terraces may be formed. Tree rows for such a planting may not be equally spaced in all parts of the orchard. On the steeper slopes the rows run closer together, while they spread farther apart on more gentle sloping areas. Where the rows are brought too close together on account of steepness of slope, parts of rows are omitted or dropped out.

Square and Rectangular Plantings.—On fairly level land with gentle slopes and where a satisfactory sod cover may be kept, the square and rectangular systems of planting may be favored. In the square plan

the trees are planted at equal distances from each other in rows running in two directions. With the rectangular system the trees may be planted closer together in one direction than in the other. For example, the trees might be planted in rows 30 feet apart with the distance between the rows 40 feet.

By spacing the rows farther apart in one direction an advantage may be gained by facilitating the various orchard operations in one direction. On lands suitable for the conservation of soil and water without terracing or planting on the contour, the use of the square and rectangular systems are still popular.

Planting Age, Spacing Distances and Intercropping

Age of Trees to Plant.—Experience and observations of fruit growers and others seem to show that in most instances well grown, healthy vigorous one-year-old nursery trees give the best results. Two-year-old trees may prove to be entirely satisfactory but in general, trees 3, 4 or more years old should not be transplanted. This is true because such older trees are apt to make a slow start in growth and the tree losses for the first 2 to 3 years may be high. The problems involved in securing a uniform and profitable planting are nearly sure to be greater when trees 3 or more years old are planted.

The one-year-old trees may usually be purchased for prices ranging less than those charged for older trees. The younger trees withstand the shock of transplanting better than older trees and come into bearing just as soon. The one-year-old tree offers the greatest opportunities for pruning and training to the desired forms and shapes. Being more vigorous they are generally resistant to the attack of fruit tree borers as well as other pests.

Spacing Distances for the Trees.—The proper distance between trees may vary considerably. This is due to the variety, soil fertility and water holding capacity. It may also depend upon the plan, if any, to thin the tree stand after a few years of cropping, and the period when tree removal is to take place. Most of the mistakes in spacing have been made by planting the trees too close together. Rarely if ever will one find an apple grower that will state that he planted his orchard trees too far apart. On the other hand, nearly all will be free to admit that close planting does not pay and if it were possible to do the job over again, larger spacing distances between the trees would be used.

When trees begin to crowd between the rows shading prevents good colored fruit from developing on the lower parts of trees particularly. At the same time root crowding may be just as serious a problem by reducing soil nutrients and moisture. The crowding of tree tops and roots, therefore, may tend to limit or restrict fruit size and color, two of the most important factors for profitable fruit selling.

For soils of average fertility, about 35 or 36 feet as the permanent spacing on the square planting plan should prove most satisfactory for moderate to good growing varieties. Such sorts as Baldwin, Gano, York Imperial and McIntosh usually grow somewhat larger in spread and height than

kinds like Winesap, Jonathan, Rome and Golden Delicious. On better than average soils the larger growing varieties, are likely to give the best results in plantings with the trees spaced about 40 to 42 feet apart. Perhaps a spacing of about 36 by 40 feet for the smaller trees would be satisfactory.

Some producers have good reasons for believing that wider spacing distances between the trees in one direction gives the best results. For instance, the planting of the trees in the row 35 feet apart in one direction and 45 feet in the other, instead of setting them on the square 40 by 40 feet. A wide center or middle between rows is made available for intercropping in young orchards. Also, when the orchards become mature, the wide middles serve well for spraying, harvesting and other orchard operations. On land subject to erosion, the closely planted rows should run across the slope instead of up and down.

INTERCROPPING.—All factors considered it is clear that the square and rectangular systems of planting which are adapted to fairly level and smooth land are most suitable for intercropping with corn, vegetables or truck crops and small fruits. When the growing of these crops is handled with judgment and discretion, it is possible in a majority of instances to make intercropping pay while the trees are coming into bearing.

However, the foremost objective should be the growing of the best orchard possible. Consequently, the intercrops whatever they are should be considered secondary or of less importance than the permanent trees. The proper cultivation, fertilization, and irrigation that may be given intercrops should be planned to be of value to the orchard trees.

Truck crops and vegetables if used as intercrops should be planted reasonably early in the spring and they should not require late summer or fall cultivation or irrigation as these practices may stimulate late fall or early winter tree growth and thus subject the trees to winter cold injury. Moreover, all planting, cultivating, irrigating, harvesting and other practices incident to the growing of the intercrop should be designed and fitted to benefit both the trees and intercrops. Particular care and attention should also be given to the matter of preventing injury to the trees through the operation tools and machinery.

HANDLING PERMANENT AND FILLER TREES

Some apple growers for their conditions believe with considerable justification that so-called "filler" trees may be handled to advantage in growing an orchard. The filler trees may or may not be of different varieties that come into bearing earlier than the permanent ones. However, the plan usually provides for the removal of the filler trees after the first few years of fruiting and before serious damage may be done to the permanent trees. A chief objection to the plan is that some growers are reluctant to remove the fillers especially if they are profitable. In such cases definite injury may be done to the permanent trees.

With trees planted on the square 25 feet apart, diagonal rows may be removed when desired, leaving the permanent trees about 35 feet apart.

If the trees are planted 28 feet apart on the square the permanent ones would stand after removal of the diagonal rows 39.6 feet apart In a similar manner, with trees planted 30 feet apart, the removal would leave the permanent trees standing 42.4 feet apart. Therefore, for a good planting distance of about 35 to 40 feet, all the trees including the permanent and semi-permanent or fillers should be spaced about 25 to 30 feet apart at planting time.

PEARS

In the United States pear production is not of real commercial importance except in California, Washington, and Oregon. These states produce nearly 70 per cent of our pear supplies. The temperature, rainfall, and soil conditions of these Pacific Coast states are favorable for heavy production of high quality fruit.

In a few favored regions near the Great Lakes plantings and production are considerable for comparatively small districts. Elsewhere pears are grown chiefly for home and local uses. The varieties, however, that are resistant to fire blight generally live longer than apple trees. As the fruit is usually less susceptible to disease and insect attack, pears resistant to fire blight may be well suited for planting in the home fruit garden.

PEAR VARIETIES.—The pear varieties in the United States have in most instances come directly from Europe. The greatest number of varieties appear to have originated in France and Belgium. With the introduction of the Oriental or sand pear and the hybridization of the species with European pear varieties, such hybrids as Kieffer, Garber, and LeCeonte were introduced. These varieties are resistant to fire blight. They meet the needs of producers by being more tolerant than other sorts of draught conditions, hot dry summers, and light soils of the central, southwestern, and southern sections.

Some seven or eight varieties of pears make up the greatest portion of the commercial production at this time. The major winter varieties of commercial pear production in Washington, Oregon and California, listed in order of ripening, are Fall Russet Bose, Comice, Anjou and Nelis. These varieties may be found on the main markets from October to June.

MAIN VARIETIES.—Tukey of the Michigan Agricultural Experiment Station has classified pear varieties into five different groups for special needs and purposes. Perhaps there is no better classification or list available. These are commercial varieties, home orchard types, blight resistant varieties, hardy kinds, and succession sorts.

Important commercial types are Bartlett, Kieffer, Seckel, Clapp and Howell. Kinds adapted to home orchards are Bartlett, Seckel, Clapp Favorite, Bosc, Richard Peters, Nelis, Dana Hovey, Tyson, Elizabeth, White Doyenne, and Bloodgood. Blight-resistant varieties are Kieffer, Richard Peters, Barber, LeCeonte, Sudduth, Seckel, Tyson, Angouleme, Buffum, Doyenne Boussock, and Giffard. Hardy sorts are Flemish Beauty, Idaho, Anjou, Sheldon, Seckel, Tyson, Winter Nelis, Lawrence, Buffum, and Angouleme. Succession varieties are Elizabeth, Tyson, Clapp Favorite, Bartlett, Seckel, Bosc, Dana Hovey, and Nelis.

For the fresh fruit market the Bartlett is the main variety for the canning and preserving trade. It is grown almost exclusively in California, and other kinds are used largely as pollinizers for it. South and west of New Jersey, including the middle western states, the Kieffer is the leading type on account of its productiveness and resistance to fire blight. A few other pears of commercial importance grown in the same sections are Garber, LeCeonte, Lincoln, Vermont Beauty, Tyson, Sheldon, Seckel, and Nelis.

In the East and New England, Bartlett is grown most extensively, but other important sorts are Clapp Favorite, Seckel, Kieffer, Bosc, Anjou, Clairgeau, and Lawrence. These varieties are grown extensively in the pear sections of Washington and Oregon. Plantings are also found in New York, Michigan, New Jersey, Delaware, Illinois, and Missouri, of such varieties as Nelis, Howell, Hardy, and Comice.

It is well known that the culture of the pear is the same as for the apple, though a somewhat heavier clay loam soil may be used. Land adapted for apple production usually produces pear trees which are satisfactory. The main difference is that the grower of pears may find a soil lower in fertility better adapted to the control of fire blight, and that this disease is usually more serious on pears than apples.

Pear Pollination.—All varieties of pears grown for commercial or home uses are considered self-unfruitful to a considerable extent. In fact, for good fruit setting they are generally more apt to require cross-pollination than most varieties of apples. Such varieties as Flemish Beauty, Hardy, Comice, and Howell which are often rated as self-fertile varieties, usually require the interplanting of other varieties for profitable fruit production.

Varieties rated as very susceptible to fire blight as Flemish Beauty, Gorham, Bartlett, Bosc, Clapp Favorite and others may be unsuited as pollinizers on account of the fire blight injury that may occur to blossoms during the blooming period. For fruitfulness, it is important that two or more varieties be used in the planting. The arrangement suggested for apple varieties applies equally well to pears.

QUINCES

The quince is not extensively grown, as about three states make up more than 60 per cent of the production. These are New York, Pennsylvania, and Ohio. The Pacific Coast states rank second in acreage, as a few quince trees are being grown in these sections in home orchards. The commercial plantings are small, ranging from a few trees to 10 or 15 acres. The fruit is not well known on the market and the demand for it is not great. It is used mainly for preserving and jelly making.

The flowers are produced on spring shoot growth, consequently the fruit bloom and young fruit are seldom injured by late spring freezes and frosts. It is nearly as susceptible to fire blight in humid warm localities as the Bartlett pear, and it is but little, if any, more resistant to winter cold than the peach. The production of the fruit, therefore, is confined to the regions of mild winters and cool, moist summers.

Leading Varieties.—There are comparatively few varieties and the difference between them is not great. Some of the leading ones are Orange, Van Deman, Pineapple, Champion, and Smyrna.

Cross-pollination of Quince.—The varieties of the quince appear to be even more in need of cross-pollination for good fruit sets than varieties of pears and apples. Just as in the case of both apples and pears provision for cross-polliniation should be made at planting time. This will consist of planting two or more varieties that bloom approximately at the same time. Furthermore, if large plantings are made, the trees should be set in blocks of two or three rows for each variety. These blocks should be alternated with each other across the orchard.

Stop Drop Sprays

Apple and pear growers are generally familiar with the use of growth regulating sprays to prevent early harvest fruit drop. Naphthaleneacetic acid (NAA) which has been the only chemical used extensively since its introduction in 1939 is now being replaced by more effective stop drop sprays. It is therefore, very important that apple and pear producers keep closely in touch with their respective Agricultural Experiment Stations for the latest and best recommendations for the use of pre-harvest sprays to prevent fruit drop before the regular harvest period.

Chapter 6

Pruning Pome Fruits

THE APPLE, PEAR AND QUINCE

Pruning consists of the cutting away of limbs or branches. For best results, the removal of superfluous, interfering, competing and unproductive wood may extend entirely over and throughout the tree tops. Pruning, therefore, is done for various purposes, some of the most obvious and practical reasons being to control and regulate growth, influence favorable flowering, fruitfulness, quality of the fruit, and repair injury. Furthermore, pruning may have a definite and marked effect upon such orchard practices as spraying and dusting, picking the fruit and general harvesting operations, cultivation and fertilization. In fact the economical and efficient handling of the pruning of the trees may help every orchard practice.

LEARNING TO PRUNE PROPERLY

Perhaps there is no one best method of enabling the orchardist to acquire the knowledge, experience and practice needed for intelligent, helpful and effective work. However, a careful study of pruning literature wherever it may be found should prove valuable and instructive. A visit or tour of orchards showing good, mediocre and poor pruning practices is suggested. Advantage should be taken of an opportunity to see or observe the work in progress. Better still, if one is able to work for a time under the direction or guidance of those doing good pruning, rapid progress is possible. Meetings and demonstrations for orchardists on pruning methods and practices are generally given high ranking for those seeking information.

VISUALIZE PRUNING

Some time spent in a thoughtful consideration of the principles and objects of pruning, coupled with a study of the fruit bearing habits of the trees or plants to be pruned, will usually make the work understandable and interesting. Likewise, the pruner must first have in mind a mental picture of the form and shape toward which he expects to prune and train the trees.

Much help may be obtained by a study of the descriptions of the forms and shapes to which trees are pruned. To be of most value, however, this should be supplemented by careful inspection and study of orchard trees which have been pruned and trained to the different types of heads.

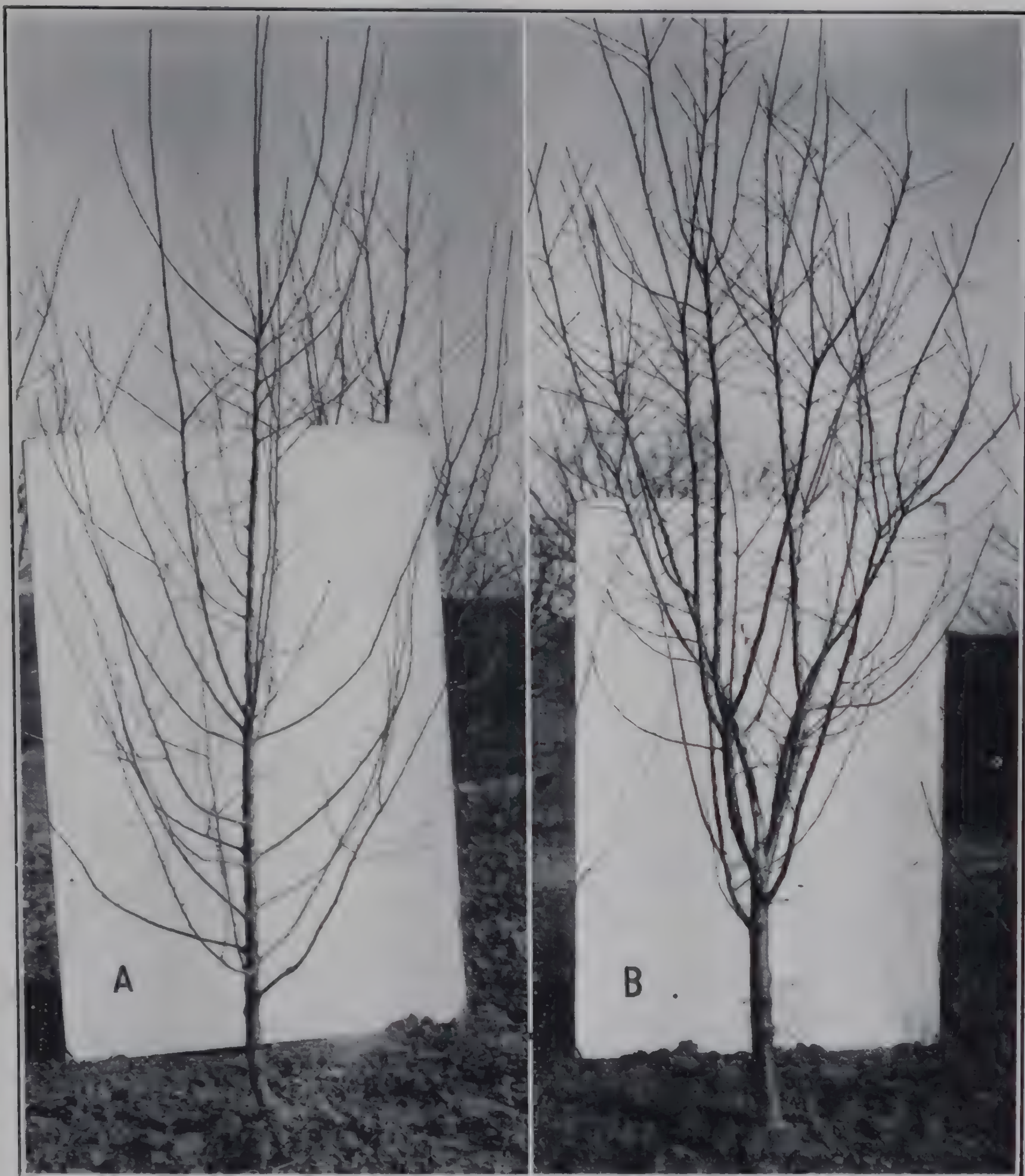

FIG. 14.—Tree A, Golden Delicious, cut back after 2 years of growth in the orchard. Note the vigorous growth, low branching and wide-angle branch crotches. Such wide-angle crotches are stronger and the limbs are less likely to split down or break with heavy loads of fruits or in storms. Tree B of the same age and variety grew in an adjoining row. It was not cut back. Note the upright growth, high head, and narrow angles between the branches and the main stem or trunk. Such branching induces limb breakage when heavy loads of fruit are borne or when subjected to ice and wind storms.

LIGHT PRUNING BEST

An extended and careful study of the general and specific effects of both heavy and light pruning has convinced experiment station workers and the best orchardists that light, timely and common sense pruning gives the best results. The pruning practices known as heavy pruning, long pruning, thin wood pruning and still others of less notoriety have had their waves of interest throughout the country. When all the methods and results are carefully considered, the decision is to prune lightly and with judgment and discretion. Hence the term "common sense pruning" is believed, in general, to be the answer.

SOME GENERAL EFFECTS OF PRUNING

There is a definite relation particularly between the leaf area of young fruit trees and their rate of growth. Also, the pruning of young trees whether light or heavy tends to reduce the leaf surface and the practice generally slows up growth accordingly. That is, heavy pruning may be a severe dwarfing process while the dwarfing effects of light pruning may not be noticeable. The time of coming into bearing may be delayed by heavy pruning on account of keeping the trees in a too vegetative state of growth for good fruiting.

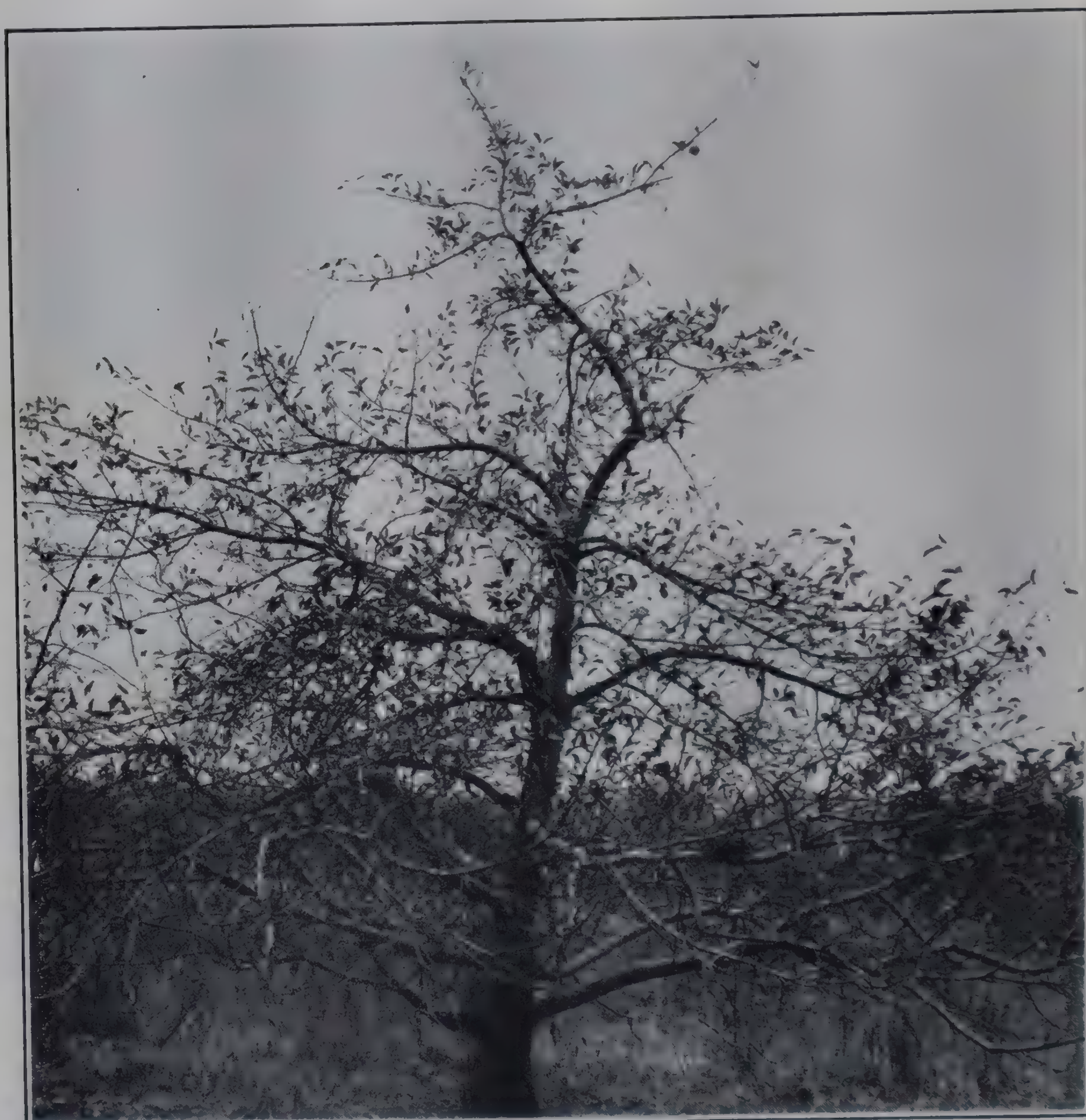

FIG. 15.—A sixty-year-old Jonathan apple tree showing low, well distributed, wide angle scaffold branches. It was trained and pruned to the so-called modified leader system. (Mo. Agr. Exp. Sta.)

OBJECTS OF PRUNING

The fruit grower or orchardist usually thinks of pruning as having to do with the altering of the shape or form of the trees and the influence that

the practice may have on the production and character of the fruit. However, some specific objectives follow:

(1) To increase the vigor of old trees and regulate the amount and direction of growth.
(2) To prevent the formation of weak and undesirable branch crotches.
(3) To remove all dead, badly diseased and injured wood.
(4) To eliminate crossing and interfering branches.
(5) To restore the balance between top growth and root system particularly of young trees at planting time.
(6) To regulate and distribute the main or scaffold branches to facilitate the bearing of heavy loads of fruit.

PRUNING BASED UPON BEARING HABIT

Apples and pears bear almost entirely on short, crooked growths known as fruit spurs. When young some varieties bear fruit from lateral buds on one-year-old wood, and from terminal buds. As the tree grows older, the general tendency, however, is to bear on spurs. Fruit spurs of both the apple and pear are produced laterally on branches at least two years of age or more. Individual spurs seldom, if ever, bear two years in succession. Normally, part of the spurs bear one year and the rest the following year. If all the spurs produce blossoms the same year, the tree is likely to develop the habit of bearing every other year. Careful and intelligent pruning should prolong the life and usefulness of the fruit spurs by allowing them to receive more sunlight.

The fruit spurs may continue to bear for 12 or 15 years. Once the fruit spurs are removed or broken off, they cannot be developed again at that particular point. Water sprouts may be permitted to grow in the bare places and develop fruit spurs. It is usually necessary to cut them back two or three times to prevent too vigorous a growth. The development of fruiting spurs through such means may prove to be a long and difficult process. It will behoove the orchardist, however, to preserve the fruiting spur growth already developed. One of his chief aims or purposes might well be to make them more fruitful, if possible, by pruning in such a way as to give the spurs more space and sunlight.

FORM OF TREE TOPS

Trees are usually trained and pruned toward three types or forms: the open head, the central leader, and the modified leader. As the natural form of the tree is now considered most productive, there is less emphasis laid upon the particular type of head. The grower should, however, become acquainted with the habits of growth of the different varieties and the form of the tree at different ages. If a particular type or form of tree has met a need and proved satisfactory it should not be changed except for very good reasons.

Open Head Type

The lateral or main branches in this type of head are generally forced to grow closer together. The open head tree has an advantage in being

lower and consequently easier to spray or prune. Picking operations may be facilitated. The disadvantages are that the main branches are closer together, the crotches are usually weaker and the trees are more apt to break when heavily loaded with fruit and when subjected to wind storms. Also the breaking of one of the main branches usually means severe injury to the tree. The trees are generally smaller and do not have as large a bearing surface as trees pruned to other shapes or forms.

Central Leader Type

In this form the topmost branch is allowed to gain the ascendency. More lateral branches may be procured, spaced farther apart up and down the trunk. Stronger crotches or angles may be formed, than in the open head type of tree. The tree would generally develop this form were no pruning done; and usually a tall, narrow tree top is the result. Some of the chief disadvantages are that varieties may grow so tall that such operations as spraying, pruning and harvesting become difficult and expensive. There is a greater tendency for two sets of branches to form with a rather wide space between giving rise to the so-called two story head. Also on account of the shading of the lower branches by the upper ones, it may be difficult at times to control fungous diseases, to obtain well colored fruit and to keep the lower branches productive.

Modified Leader Type

This type of head is generally considered the best one to which trees may be trained and pruned in their early years of growth. Not only a lower and more spreading tree than the central leader is produced, but a larger number of well placed lateral fruiting branches may be developed, and a more satisfactory fruiting system is established than in either of the other types of tree heads.

In the modified leader the central stem or leader is allowed to grow much as in the case of the central leader type, but it differs from the central leader type in that from time to time the leader is lightly suppressed by cutting it back. Hence the name, "Modified Leader." To produce this type of head the main stem or the highest branch located near the center of the tree top is allowed to grow a little faster than any of the lateral or side branches about it. The modified leader tree is thus formed by adding each year a length of 18 to 20 inches to the main stem. Upon this a few well placed main branches are allowed to grow. When a height of 6 or 8 feet is reached, the leader, if not already suppressed sufficiently, may be removed. The suppression of the central leader at intervals generally tends to produce a tree less in height than the central leader and with stronger crotches than are formed in the open head type of tree. Such tree should have as great a bearing surface and as strong branches as the central leader tree. It has the distinct advantage, therefore, of being lower; and the form of such a tree is usually the one naturally best suited to the particular variety. The tree can be kept more open in the center than the central leader, thus admitting more light.

Low Headed Trees Best

It is obvious that low headed trees facilitate such orchard operations as spraying, harvesting the fruit, pruning and fruit thinning operations. Experimental work has shown that low headed trees generally show a more vigorous condition and greater trunk and root development than high-headed trees. Wind storm damage is almost sure to be much greater when trees are trained and pruned to high heads.

With scaffold branches fairly close to the ground shade is provided for the lower portions and bases of tree trunks. Sun scald and winter cold injury particularly on the south and southwest sides of tree trunks may be reduced markedly. As a result the damage done to fruit tree trunks by borers and canker diseases is generally lessened. In fact, there are few if any valid or worthwhile reasons for high-headed orchard trees.

PRUNING AT PLANTING TIME

In the north and north-central sections of the United States where winter cold injury may be likely, the pruning of late fall or early winter planted trees may be postponed until early spring. However, the winter cold damage problem following late fall or early winter pruning, does not concern producers materially if located in districts and sections toward the south central and southern areas of the country. In any event, the proper pruning of trees whether planted in late fall or early spring should be done early in the spring as soon as weather conditions permit. Also, as suggested above toward the south including south central areas pruning soon after planting in late fall or early winter should not in general subject the trees to the likelihood of greater injury by winter cold.

Pruning of the tree top restores the balance between the root system and the top of the trees. Many tree roots are destroyed at the time the trees are dug for transplanting. With one-year-old trees that usually form a straight whip or stem, the pruning consists of cutting the trees back to a height of about 28 to 36 inches from the ground. The main or scaffold branches are then forced out below the point where the cut was made. The height of the tree head, therefore, may depend largely upon the height at which the tree is topped or headed. The main or scaffold branches usually start from buds in a space about 10 to 14 inches immediately below the point at which the tree is headed.

When two-year-old trees are planted, there may be two to five or more branches. Remove all but three or four and cut back remaining ones to a length from 6 to 10 or 12 inches. Shorten the leader to a height of about 36 to 40 inches from the ground. In some cases it may be best to remove all of the side or lateral branches to secure a satisfactory framework of branches. A height of 28 to 36 inches is generally selected. Such trees are then handled like one year olds.

The roots of young trees are usually cut back to a length of 8 to 10 inches and diseased roots or badly mangled roots are generally removed. The leaving of extra long roots is not advised.

PRUNING YOUNG APPLE TREES UNTIL BEARING AGE

For the first five years, corrective pruning is suggested. This consists largely of thinning out thick clusters and interfering or competing branches. Cutting is not severe, and it does not delay bearing materially or reduce appreciably tree size. This is the time to select fairly wide angle scaffold branches spaced 6 to 12 inches apart up and down and around the trunk. A low spreading tree is desired. To attain this the central leader may need cutting a time or two lightly. The tree is trained and pruned to its natural form as nearly as possible. The pruning done is to facilitate the habit of growth rather than to change it. The object of the pruning is the development of strong, properly placed branches which will carry heavy loads of fruit.

A light pruning each year should keep the branches properly spaced and in balance. To facilitate spraying and pruning, small side branches on scaffolds should be removed in sufficient numbers to allow entrance to the main stem or trunk at three or four places from the periphery or outside. Moreover, pruning should be reduced to the minimum as the trees come into bearing. The pruner should keep in mind the fact that the most productive orchards are usually the ones receiving the least pruning.

PRUNING BEARING APPLE TREES

As the trees come into bearing the objective should be to allow the different varieties to assume their natural forms and shapes. Furthermore, this is accomplished by reducing the amount of pruning to the minimum. By so doing, fruit production may be encouraged. At all times, however, the removal of thin unproductive wood toward and in the centers of tree tops and in the shaded and lower parts should be helpful. Now and then rangy branches of the tops and sides will need shortening back, thick clusters of branches will require thinning, and interfering and crossed limbs are removed one or both. As fruit bearing begins, it is seldom advisable to remove limbs larger than about 1½ inches in diameter. Where the pruning work proceeds moderately and is given attention regularly each year rarely will heavy cutting be needed.

As the outside portions of the trees usually bear the most profitable fruit, growers try to develop and maintain as much of such bearing surface as possible. Through growth and cropping the spread of the trees is increased with age, and with low branches properly spaced and thinned good fruit may be borne from the ground to the tops. Judicious and intelligent pruning may help considerably to increase the size and color of the fruit produced.

Mature apple trees of from about 18 to 24 years of age, may bear approximately one-half their crops on the outside parts of the trees. On account of the higher color of the fruit produced here, it may grade higher and sell for better prices than the fruit of medium to poor color found on the inner, lower and shaded portions of the trees. It is important that the maximum bearing surface be exposed to sufficient sunlight for the good coloring of the apples should be sought through careful pruning methods.

The different varieties of apple and pear trees may require for best results, different degrees and slightly unlike types of pruning. The extent of growth, age of the trees, previous methods of handling are factors that may influence pruning. In general, the natural forms and shapes of the trees are sought and weak crotches and unproductive wood are reduced to the minimum. Exposure of the fruit bearing surfaces through pruning to allow sufficient sunlight for as much development of color as possible, and the keeping of the trees to manageable heights and spreads are other goals.

Time to Prune

If pruning work is done properly, corrective pruning may go forward at almost any season of the year. Certainly the removal of dead, badly diseased limbs and broken branches as soon as found should prove profitable. The period following the dropping of the leaves in late fall and before the leaves appear in early spring is usually considered best for the bulk of the pruning work.

In large orchards, the chief problem may be to secure sufficient labor to do the pruning job. It may be important, therefore, that as much of the period mentioned above or the dormant season, be use as possible. During the winter season, when the wood is not frozen and when men may work outdoors in comfort, pruning toward the southern and central areas may be carried on with profit. The main objections to pruning when the wood is frozen is that frozen branches and fruit spurs are very brittle and easily broken.

Winter Cold Injury

In the northern sections where winter temperatures may drop to zero and considerably below it is usually advisable to postpone especially heavy pruning until the danger of low temperatures are past. This suggestion applies particularly to the practice of heavy pruning. If low winter temperatures follow pruning much more cold injury may be done to trees where large wounds have been made than where small wounds occur. Light pruning, however, making cuts no larger than about an inch in diameter should not in general cause material injury even if followed by fairly low temperatures. Should somewhat heavier pruning be needed this may follow the light pruning at a later time and when there is no likelihood of damage from winter cold.

Treatment of Pruning Wounds

The wounds made in pruning young orchards are usually small or less than about 2 inches in diameter. It has been found that such wounds do not require treatment for good healing. In older orchards where cuts may range, occasionally, from about 3 to 5 inches or more in diameter, it is generally advisable to cover the wounds within a few days after pruning using a wound dressing or paint prepared or adapted for the purpose.

Several good pruning wound dressings may be secured from concerns supplying spraying chemicals and other products to orchardists. In using such materials, the directions should be followed carefully in making applications.

By mixing powdered bordeaux spray with raw linseed oil to form a product of the consistency of paint, a satisfactory wound covering may be made. Some growers still use successfully house or barn paint of the desired colors. To keep large wounds covered and prevent checking and cracking, repainting once a year or more often may be required.

The Michigan Station reports the following proprietary mixtures as being worthy: "Flint Kote Static" and "Foster's I.B.M." Still other products that are used are asphalt mixtures, grafting wax, whitewash, cold tar preparations, paraffin, zinc, paints, and water glass.

Pruning Damaged or Weak Trees

Young fruit trees of one or more years growth in the orchard are often damaged seriously by hail, rabbits, borers, or from other causes. The Missouri Agriculture Experiment Station has found that such young trees may be cut back to stumps from 4 to 6 inches high early in the spring. Also, trees that make a poor, stunted or weak growth may be subjected to similar treatment. If sprouts arise from the remaining portion of the stem and continue growth, a satisfactory tree may be produced. The best sprout starting above the graft or bud union should be allowed to grow to take the place of the top or part removed. This applies particularly to young apple and pear trees.

Early in the spring just as growth is starting or shortly before, was found to be the best period for cutting back young trees. The later the cutting back in the spring, the less likely the tree is to produce satisfactory sprouts to continue the growth of the tree top.

In comparison to normal or untreated trees, no material difference has been noted in the age of coming into bearing between untreated trees, trees cut back at planting time, and after one to two years' growth in the orchard. Trees cut back after three or four years' growth in the orchard, may, however, be delayed in coming into bearing as much as two or more years.

In cut-back trees the main or scaffold branches start much nearer the ground. Well placed branches may push out at heights from 14 to 18 inches above ground and spread out at a much wider angle than branches from trees not cut back. The branches are better placed up and down the main stem of the tree trunk, enabling the pruner to select without difficulty the branches desired for a well-shaped and well-balanced head. Moreover, cut-back trees usually exhibit much stronger or more vigorous growth than similar untreated trees.

Good Pruning Tools

No one would expect a competent carpenter to do satisfactory work with a poor and inadequate kit of tools. Likewise no matter how much ex-

perience and training the pruner may have had or the extent of his information on pruning, he is not likely to do satisfactory work unless he has access to good tools.

For most orchardists, perhaps the two most important tools are the swivel pruning saw and hand pruning shears. In fact, these two implements may be sufficient for the handling of the pruning task until the orchard comes into bearing. However, now and then the pruner may need, even in the young orchard for rapid and economical work, other tools such as a curved or "half moon" saw, and a pair of long-handled shears or loppers. For bearing orchards and in pruning old trees, where heavier work or larger limbs may require removal, a larger pruning saw may be needed. But few if any other pruning tools will be required in the average orchard. It is also essential that all pruning tools be kept sharp and in good condition for use at all times.

Power Pruning

Orchardists in their endeavors to improve the quality of their fruit, increase yields and reduce costs, are now using and experimenting with power driven pruning equipment. Producers and investigators that have given power pruning careful study in both the laboratory and orchard maintain that this development is here to stay and that rapid and substantial improvements in the machinery and methods may be expected. Perhaps, this is just another illustration of what science and engineering are doing for the fruit growing industry.

A typical power pruning outfit was used successfully in 1949 and 1950 in a commercial peach orchard. The same equipment was used in pruning apple and pear trees coming into bearing. It consisted of a 17 cubic-foot air compressor mounted on a tractor, with drive from the power take-off. Four 50-foot lines of air hose were used.

Another ingenious orchard machine is known as the "Steel Squirrel." It supports two telescoping towers on revolving bases that allows two pruners at the touch of a lever, to move at will around and up and down the tree. For raising, lowering and swinging there are three levers. The towers are hydraulically operated by the two workers for pruning, fruit thinning, or picking fruit. Power is supplied by a compresser mounted on a trailer attached to the rig. Although not self powered, the outfit can be easily moved to different locations by tractor or Jeep.

Removal of Pruning Brush

The prompt and economical removal of pruning brush as soon as possible after the pruning work is done may constitute a considerable problem. The old method of the past has consisted of picking up the brush by hand, stacking it in piles between the rows and then hauling it out of the orchard to the burning grounds. For small areas this method may still be satisfactory.

In large orchards many different types of homemade equipment designed to facilitate the removal of orchard brush is being used. Spring tooth-brush

rakes appear in general to give good results. The so-called buck rake is often used for the disposal of the largest and heaviest branches as well as the small ones. Brush burners have also been used with some success. The heat developed by the burner has in some instances damaged tree branches and trunks. Also, there is always the likelihood of starting grass fires in the orchard. Motor driven brush shredders are replacing brush burners. The shredders chop and grind the brush into small pieces and shreds. The materials are then scattered on the soil between the tree rows. In many instances orchardists are handling the problem for their particular needs to reduce costs and speed up removal, by making and adapting equipment that suits their requirements best.

ORCHARD SANITATION

All orchardists will generally agree that sanitary measures that are compatible with sound and practical orchard methods are to be encouraged. The practice of good orchard sanitary measures in pest control may supplement to excellent advantage spraying practices.

Pruning.—In pruning cut out and burn all dead twigs, limbs, split and badly diseased branches and worthless wood. If the branches in the tops of the trees and on the sides are thinned out and the height of tall trees is reduced by cutting to outgrowing side branches not more than an inch or two in diameter, good spraying coverage of the trees will be made easier.

Removal of Rough Loose Bark.—Remove all rough and loose bark from crotches, trunks, and branches. Instead of scraping the bark off by hand, which is a time consuming process, use a water spray. The "barking off" is done during the winter or by about the latter part of March or early April. Rough bark removal destroys a large percentage of the overwintering larvæ of the codling moth and prepares the trees for banding against the codling moth worms.

Standard spray guns equipped with a disk having about $\frac{8}{64}$ inch opening (No. 8 disk) is generally used at 500 to 600 pounds pressure. The spray guns should move up and down and around the tree trunks where rough scaly bark occurs. Avoid holding the gun in one position too long, as the water under such high pressure may split and tear the bark to the growing layers thus causing considerable injury. This method lends itself readily to cleaning out large branch crotches and the removal of punky wood from pruning wounds and branch or trunk injuries. About 2 to 4 minutes may be required to remove the rough bark from a mature apple tree.

Chemically treated bands if placed on the trunks of the trees after rough bark removal may reduce summer broods of codling moth larvæ as much as 50 per cent. Apply treated bands to apple tree trunks early in June for most apple sections. Growers should rely, however upon the State Agricultural Experiment Stations for the most accurate directions as to trunk banding practices adaptable to the particular area or district.

Remove Dropped Fruit and Screen Packing House

In fruit thinning, remove and burn all fruit infected by worms, scab, blotch and rot. Collect and remove dropped fruit. Screen the packing shed in late winter and enclose in it crates, ladders and other orchard equipment that may harbor codling moth. This may help in the control of the insect pest. The codling moth in the larvae stage may have wintered in the enclosure or on the equipment. If screened in, the adult moths upon emergence will be unable to fly to the orchards and will perish.

Chapter 7

Culture of the Peach, Nectarine, Apricot and Almond

Peach Growing

AUTHORITIES generally agree that the original home of the peach (Prunus Persica) is China and from that country it was introduced into Persia and perhaps from Persia into Europe. The Spaniards are believed to have brought both peach seeds and trees for planting to America on the second, third or both voyages of Columbus. Once established, conditions were found to be satisfactory for its growth and extension. Descendants of the earliest plantings of peaches escaped to the wild and uncultivated areas. Some of these so-called wild peach trees may still be found in regions of South Carolina, Tennessee and adjoining states.

Furthermore, no other fruit except the apple has been grown more widely on a commercial scale in the United States. Next to the apple, peach cultural practices have been given the most attention by both producers and investigators. Perhaps the fruit is worthy of its classification "Queen of Fruits."

The Peach Industry

Based upon a 10 year average, data shows that California is decidedly the leading peach growing state. Production here may account for as much as 40 to 60 per cent of the total for the United States. Moreover, the production in California is more stable and uniform than the crop produced in the East where on account of winter cold and late spring freezes and frosts, fluctuations in production are common and to be expected.

According to the United States Department of Agriculture, the crop growing figures for leading states 1937–46 averages in bushels are: California, 27,373,000; Georgia 5,037,000; Michigan, 3,310,000; Washington, 2,081,000; North Carolina, 2,131,000; and Pennsylvania, 1,960,000. The total yield for a short crop in the United States in 1950 was 52,407,000 bushels. The 10 year average, 1939 48, is approximately 70 million bushels.

In the eastern states, nearly all of the crop is disposed of on the fresh fruit markets. This is particularly true of all the states excepting Michigan and Washington in the West where sizeable quantities of peaches are canned by concerns that are growing and extending the processing industry. California, however, which may be depended upon for substantially more

than half the production, may sell in the fresh state comparatively small quantities as processing industries handle the major portion of the crops.

Selecting Peach Varieties

There is no perfect variety of peach and the kinds or varieties planted may "make" or "break" the grower. Fertile soils and good culture will not make poor sorts profitable or low-yielding kinds fruitful. Often returns from one variety may barely cover production and harvesting costs, while those from another net substantial profits.

Varieties, however, cannot be valued entirely on the basis of yield. Relative susceptibility to insect and disease attack, earliness of bearing, regularity of cropping, length of life, percentage of fruit that grades out, market demand and price must all receive careful consideration. Hardiness in wood and bud to winter and spring cold and resistance to injury from the heat and dryness of summer are also of great importance.

ELBERTA.—Elberta is still the most popular peach on the markets. Its wide and favorable reputation on local and distant markets gives it a distinct and marked sales advantage. Elberta is also outstanding on account of its handling and shipping qualities. These advantages, coupled with the tendency of the trees to bear regular and abundant crops, make the Elberta a leading commercial variety. The trees are not as hardy in bud or wood as some other less desirable sorts, and the fruit cannot be rated high in quality. With no other variety to replace it for shipping quality or as favorably known on the distant commercial markets, Elberta may continue to be a favorite for a long time, particularly for distant shipments.

The "Best Varieties"

It is obvious that definite varieties cannot be recommended as "the best" under all circumstances. In each fruit-growing district there are generally four or five well known and established sorts which can be relied upon. The bulk of new plantings should be selected from this list. New varieties should be planted in limited numbers as several years' observation by investigators and experienced growers are needed before their commercial value can be determined. This makes the acceptance of newcomers slow.

Varieties adapted for home and nearby uses may differ materially from those selected for commercial production. This may be especially true where long distance shipments are contemplated and handling and keeping qualities naturally become tremendously important factors. Home and local markets may demand a succession of varieties ripening over a considerable period of time. Both commercial and small producers of peaches may profit, therefore, by consulting successful peach growers having climatic conditions and soils comparable to those where plantings are to be made. Furthermore, the local county agent and the state experiment station are important sources of information on varieties that may be best suited to local needs and marketing opportunities.

A list of varieties of peaches arranged in order of ripening for home or market uses follows. There may be other varieties that should be included for some districts and for particular important needs. For the country as a whole, however, it is hoped that the list submitted for study and investigation for plantings according to desires and good production may be found worthwhile.

VARIETIES OF PEACHES IN ORDER OF RIPENING FOR HOME OR MARKET PRODUCTION
(Southeast Missouri)

Variety Order of Ripening	*Hardiness*	*Flesh Color*	*Adhesion of Pit*	*Days Ripe Before and After Elberta*
* Red Bird	Very hardy	White	Cling	44
* Mikado	Hardy	Yellow	Semi-cling	37
* Early Rose	Hardy	White	Cling	35
Raritan Rose	Hardy	White	Free	30
Golden Jubilee	Hardy	Yellow	Free	30
* Alton	Very hardy	White	Semi-cling	30
* Cumberland	Very hardy	White	Free	30
Red Haven	Hardy	Yellow	Free	35
Fair Beauty	Hardy	Yellow	Semi-free	23
Goldeneast	Medium	Yellow	Free	20
Midway	Hardy	Yellow	Free	20
Vedette	Hardy	Yellow	Free	18
Halehaven	Hardy	Yellow	Free	17
Triogem	Hardy	Yellow	Free	26
* Golden Globe	Hardy	Yellow	Free	17
Eclipse	Very hardy	Yellow	Free	26
Hiley	Hardy	White	Free	18
Champion	Hardy	White	Free	10
Polly	Hardy	White	Free	10
Belle	Very hardy	White	Free	7
Early Elberta	Hardy	Yellow	Free	3
Elberta	Medium	Yellow	Free	0
J. H. Hale	Medium	Yellow	Free	− 3
Shipper's Late Red	Hardy	Yellow	Free	− 3
Salberta	Hardy	Yellow	Free	−16

* These varieties are not being planted as extensively as formerly.

Promising New Peach Varieties

Interest in early fruiting sorts is largely confined to the southern producing sections. This is true because earliness may bring premiun prices. Furthermore, some of the new early varieties are distinctly superior to the old ones. Perhaps of the early varieties Maybelle, a white peach, and Tulip, yellow in color are most promising at this time. They both follow Mayflower in ripening but mature before Uneeda, Mikado and Early Red Free.

A new early clingstone peach following this early season is Dixired. It is large with red flesh and is attractive in appearance. The quality of this variety in comparison with Red Bird would be rated as excellent.

Dixigem, Redhaven and Jerseyland early free-stone varieties are about equal in popularity. Others still in the testing stages are Early East, Starking Delicious, Missouri, Early Jubilee, Prairie Daybreak, Merrill, June and others.

Winter Injury

The wood of peach trees will withstand without injury considerably lower temperatures than the fruit buds. When buds are dormant and the trees vigorous, there is less likelihood of injury than when opposite conditions of trees and buds exist. Furthermore, low temperatures of short duration may be less damaging than if prolonged for a considerable period. Temperatures several degrees above zero in early winter, following late fall growth, may cause injury to both trees and fruit buds.

Mild or unseasonable weather in January or February may cause peach fruit buds to start growth or swell enough to become tender to cold. If even normal cold weather follows such warm spells, much damage to fruit buds may be done. The total or partial loss of crops through these more or less wide ranges in temperatures is in general more prevalent in the southern peach districts than is the loss from low temperatures in the northern districts.

Spring frosts that occur during blossoming time may also cause great losses to the peach crop. In fact, if severe spring frosts appear year after year at blossoming time, commercial peach growing is not practicable. Danger points of temperature at the blossoming period, as given by many investigators throughout the country, range from 25° to 30° F.

When the wood of trees has been injured by very low temperatures, it is advisable to postpone pruning until late enough in the spring to determine the extent of injury. Winter injured trees require very careful treatment. If the injury is not severe, the dead parts should be removed and the remainder of the tree pruned throughly to stimulate growth. The cutting should not be heavy because the trees may have already lost a considerable amount of their potential leaf-bearing surface. Since the leaves manufacture food for growth, it is important that a sufficient area of leaf-bearing wood be left for good growth. In overcoming winter injury, thorough cultivation and fairly liberal fertilization are generally helpful.

Sites and Location

An ideal site should be high enough to allow cold air to drain off readily, and without bare slopes above which will permit cold air to drain down through the orchard. The aspect or direction of the slope is important. North slopes are generally cooler in both winter and summer and possess deeper and more fertile soil than southern exposures. Since warm spells in January and February are more likely to start fruit bud growth on south slopes, northern exposures are generally preferred. Slopes in other directions may show differences in temperature and soil fertility but usually not as marked as that of north and south exposures.

LOCATION.—Peach growing in a location where the fruit is produced extensively has advantages. Supplies and repairs to machinery may be more quickly and easily obtained, growers may have less difficulty in keeping informed on the best orchard practices, grading and packing can often be done in a cooperative plant, and such concentrated plantings may aid materially selling operations.

On the other hand, peach orchards located in areas where the plantings are scattered may have advantages of local, independent markets and outlets not found in regions where extensive commercial orchards have been established. It is also true that the isolated peach plantings may suffer less from the build-up of injurious insects and diseases harmful to the peach.

Choosing Peach Orchard Soils

Peach trees may produce profitable crops on a great range of different soil types. They usually thrive best, however, on the light sandy, gravelly, or rocky loams which are fairly fertile. The trees will not endure wet or water-logged soils. In fact, regardless of type, the soil must be well drained. While peach trees will succeed on poor soil, yet the best results may be secured on moderately fertile, loamy, deep well-aerated soils.

FIG. 16.—Supplementary irrigation increases yields in years of normal rainfall and may insure crops against serious loss in years of drought. (Courtesy of Aluminum Company of America, Pittsburg, Pa.)

Soil and Moisture Conservation

Contour planting of peach trees is recommended as a standard soil and water saving practice for use on all erosive sites where cultivation is to be practiced to any significant extent as a part of the cultural system. The only exception to this plan would be where an uneven topography makes contour planting impractical in which case other conservation methods

such as mulching should be substituted to as great a degree as possible for the first 2 to 4 years when special attention is necessary for the establishment of the planting.

It should be thoroughly understood that contour planting is without merit unless used as a basis for other soil and water saving practices such as terracing, ridging and simple contour cultivation. Contour planting and the practice of terracing, therefore, are helpmates of each other. Either may not be successful without the aid of the other.

In general, contours and terraces cannot be laid out properly without the use of surveying instruments by competent persons. The county extension agent may be depended upon to either give the assistance needed or refer the grower to reliable individuals or sources where help can be procured.

On sloping grounds that tend to erode or wash badly, strip cultivation 6 to 8 feet wide along the rows of trees on the contour may be practiced. On still steeper slopes or hillsides cultivation may be confined to hoeing or spading at intervals of about 2 weeks, an area about 4 to 6 feet in diameter around the individual trees in spring and summer until they become established. Under such conditions mulching may often be substituted for cultivation with equally good results. Where the mulch can be reinforced with manure or nitrogen fertilizers, this will be especially true.

Pollination Requirements

The peach, with the exception of a few varieties, is self-fertile. Self-fertile varieties, therefore, may be planted in solid blocks. All agree, however, that better sets of fruit may often be obtained if several varieties are planted in strips of two rows each, alternating with each other across the orchard. Some of the self-unfruitful varieties, possessing non-viable pollen are:

Candoka	Japan Cling
Chili	Mikado
Chinese Cling	Pacemaker
Halberta	Sargents
Hope Farm	Tuscan Cling
J. H. Hale	Vimy

However, J. H. Hale is the only one that has been planted widely. For these varieties provision for thorough cross-pollination should be made. Practically all of the so-called standard sorts such as Elberta, Champion, Red Bird, Belle of Georgia, and others should prove very effective in cross-pollination. If self-unfruitful sorts are planted in alternate blocks of about 2 rows each across the orchard with an additional row planted in each block as a pollinizer, cross-pollinization facilities should be adequate.

Use of Honeybees for Pollination

In general, we cannot depend upon the wind as a satisfactory agent for cross-pollination at blooming time. For young orchards just coming into bearing, one good colony for every 3 to 5 acres should be sufficient. In

old orchards where there is a much greater spread and height of trees giving an extensive and large blooming area, one good hive of bees per acre may be needed. The same suggestions regarding pollination and fruit setting at blooming time apply equally well to nectarines, almonds and apricots.

Preparation of Land for Planting

On fairly level land which is not likely to erode badly, the soil may be prepared thoroughly by plowing, disking and harrowing, just as one would prepare land for the planting of wheat, corn or potatoes. Trees generally respond markedly in growth and development to good soil preparation before planting.

What, When and How to Plant

The best nursery stock obtainable is usually the cheapest in the long run. It is false economy to plant inferior or low grade trees. The best trees are more likely to be true to name. Well matured healthy stock withstands transplanting better, is more resistant to dangerous insects and fungous diseases, comes into bearing earlier, and develops into a more profitable orchard than small, stunted, and less desirable trees. In the southern districts late fall and early winter planting is suggested. For central and northern sections, however, on account of danger of winter injury to the roots, spring planting as early as soil and weather conditions permit has been general.

One-year-old thrifty trees are preferred and they are set from 22 to 24 feet apart each way. Broken or injured parts of roots should be removed before planting. Dig the planting hole large enough to allow the roots to be spread without cramping and the trees to stand about an inch deeper than they stood in the nursery. As the soil is filled in around the roots, firm it by tramping.

Handling Young and Mature Trees

Balanced Growth Needed.—In general the producer should strive to secure on young non-bearing trees an average yearly growth of about 30 to 40 inches and on bearing trees a terminal growth of 10 to 14 inches is desirable. Slight variations in these growth figures may not affect adversely the health, growth and fruitfulness of the trees when they come into bearing. But marked reductions (3 to 4 inches total) or accelerations (40 to 50 inches or more) in growth may affect profoundly both the time and amount of fruiting. It is common knowledge that young peach trees have a tendency to make greater growth and to grow later in the season than bearing peach trees.

Good Early Growth Desirable.—With good cultural practices and proper fertilization the trees should start growth early and begin to slow down for the season by about the middle of July. This will give the new wood plenty of time to ripen and harden off for the winter cold. On the other hand, if the trees continue to make a rank and succulent growth through August and into September, wood ripening and hardening for

winter conditions may not have a chance to take place before the leaves are killed by the frost and cold of winter.

Cultivation and Cover Crops.—On sites that are fairly level and where erosion is not a serious problem, the peach grower may, as has been the common practice, cultivate early in the season and sow a cover crop in late spring or early summer. Producers everywhere, however, are now giving the matter of erosion control more attention. Grass or sod strips in depression areas and elsewhere are left uncultivated in order to facilitate the removal of water without the washing away of the soil. Up and down hill cultivation has been entirely eliminated. The great value of maintaining an adequate supply of humus in the soil at all times to lessen leaching and erosion and to accelerate growth is appreciated more among producers generally than ever before.

Need of Soil Organic Matter

All of the stone fruits thrive best in a soil well supplied with organic matter. Cover crops fill this need adequately. Such crops as cowpeas and soybeans may be sown as soon as cultivation ceases. Hairy vetch and rye may be preferred and seeded about the middle of August. Wheat, rye, barley and winter oats with vetch, crimson clover, and bur clover are also sometimes sown during late August and early September. The legumes may also be sown alone. The cover crop may be left on the surface and trashy cultivation adopted instead of plowing it under and practicing clean cultivation as has been the practice in many orchards.

To get the largest amount of growth, it may be well to fertilize the cover crop. Where this is necessary, a light dressing of a complete commercial fertilizer may be found of great value. Legume crops, particularly, will respond profitably to phosphorus-carrying fertilizers.

Use of Fertilizers

As the trees come into bearing it will usually be necessary to supplement the cover crop culture for building and maintaining the soil organic matter and nitrogen with applications of nitrogen fertilizers like nitrate of soda, sulphate of ammonia and ammonium nitrate. Both spring and fall applications have been profitable. Fertilizing at blooming time or shortly before is generally practiced. The amount used then is largely dependent upon the prospects for a crop. Regardless of the amount of bloom, if the trees need more growth, they should be fertilized. Trees 5 to 6 years old in most cases will need 2 to 3 pounds yearly and older trees may require as much as 3 to 5 pounds per tree for good growth and fruitfulness.

Manure may be particularly valuable in bearing orchards on very poor soil or where there is too much shade for the growth of a good cover crop. Moreover, it is important that manure, which is slowly available, be applied in the winter or very early in the spring. Applications made late in the spring or in summer may induce a late tree growth. This would delay maturity, lessen the color of the fruit, and increase the likelihood of winter injury.

In every planting, whether to fertilize and how much to use are questions that must be considered. The best answer will usually be found in a study of the growth and yield records of the trees. If an annual growth of less than 20 to 30 inches is being made on young trees and less than 10 to 14 inches on bearing trees, a nitrate fertilizer should prove worth while.

The amount of fertilizer to use on peach trees will depend on the fertility of the soil and the condition and size of the trees. On the average a moderate application of manure for large bearing trees would be about $\frac{1}{5}$ ton per tree. The same trees would receive in commercial nitrogen about 3 pounds of sodium nitrate, $2\frac{1}{4}$ pounds of ammonium sulphate, or 2 pounds of cyanamid. Young trees 2 or 3 years old will not usually require more than $\frac{1}{2}$ pound of sodium nitrate, $\frac{1}{3}$ pound of ammonium sulphate or $\frac{1}{4}$ pound of ammonium nitrate to a tree. The percentage of nitrogen in these fertilizers is as follows: Sodium nitrate 16%; ammonium sulphate 20%; and ammonium nitrate 32%. All of these fertilizers are usually spread broadcast under the spread of the tree branches and a few feet beyond the ends of the branches.

PRUNING THE PEACH TREE

Young Trees.—The sooner a peach tree can be grown to bearing size and proportions the quicker it will begin to bear paying crops. The least amount of pruning required therefore to train and form a strong and well balanced tree, the better. The pruning for peach trees is generally fairly severe, yet heavy pruning has a dwarfing effect upon young trees and delays and decreases early crops.

Open-center Method.—Most varieties of peaches are inclined to form an open-center type of tree head. Trees are generally headed back soon after planting to a height of 18 to 24 inches, the greater height being used for large vigorous trees and the smaller for less vigorous ones. Low headed trees are desired because they make orchard operations such as pruning, thinning, spraying and harvesting easier and less expensive.

In the open-center tree from three to five scaffold branches may arise from a relatively short space on the trunk. If more than three of these main branches are retained, there is danger from the formation of narrow, weak crotches and poor unions. When three scaffold branches, fairly close together, and well distributed around the trunk are chosen, they may form a compact strong tree head.

If the scaffold branches are large and uniform in size they are generally headed back to a length of about 10 to 12 inches, but if they are comparatively slender, weak and uneven in development, it is usually advisable to cut them back to short stubs about 2 to 3 inches long. Three new shoots arising from the basal buds of the short branches and well distributed around the tree head are selected for the main scaffold branches.

In two or three weeks after planting and pruning, all of the new shoots arising from the trunk and shortened branches should be removed except the three that are selected and left to form the main head. Another inspection of the young trees should be made in two or three weeks after

the first one. At this time additional corrective shoot thinning and removal may be required.

Pruning for second and third years should also be light and of a corrective nature. By this time the trees should have in general assumed the shape and form of mature trees. In this formative period of three to four years, the object is to develop a strong balanced framework. The general appearance of the trees should be spreading and bowl shaped in order that high-colored fruit can be produced. More danger arises from too much pruning than too little. Trees making a poor growth are pruned heaviest while those producing strong shoots and laterals are pruned least.

FIG. 17.—Four-year-old Elberta peach tree showing amount and type of pruning after all the fruit buds were killed by January cold. (Mo. Agr. Exp. Sta.)

THE MODIFIED LEADER METHOD.—In this method the central stem or leader located in or near the center is allowed to gain the ascendency. The system for peach trees is not quite comparable to apple or pear trees, for example. This is true because the central stem or leader as a rule instead of developing upright grows at an angle of about 45 degrees.

Strong vigorous trees lend themselves better to this type of pruning than medium or small sized trees because it is necessary to select the scaffold branches during the first year. Consequently, it may usually be better to train the less growthy trees to the open-center method.

The trees are headed at a height of about 36 to 40 inches and beginning at a height of 10 to 12 inches from the ground the limbs are cut back to stubs about 2 to 4 inches in length. The main or scaffold branches are then selected at the end of the first year of growth.

In training and pruning peach trees toward the modified leader method greater care and skill is required than in pruning apple trees to this system,

because the peach is inclined to form an open-center head. Neither the upper nor lower scaffold branches should be allowed to dominate the other. Care must be taken to prevent the development of a two-story tree consisting of both a lower and upper set of branches with an open space between.

In the second and third years particularly it is important that a tree be produced with wide-angle branches arranged about 6 to 8 inches apart up and down and around the trunk. In the first growing season it may be best to leave all the scaffold branches so that a choice of branches with wide angles may be made the second year.

FIG. 18.—A typical four-year-old Elberta peach tree trained and pruned to the Modified Leader Method. Note, the strong, wide-angle crotches of the scaffold branches with the main trunk and the well balanced symmetrical top. (Mo. Agr. Exp. Sta.)

Pruning Bearing Peach Trees

The peach tree bears fruit on 1-year-old wood which tends to grow farther out on the ends of the branches each year. The first problem, therefore, confronting the grower in pruning bearing trees is the fact that fairly heavy pruning at least once in 2 or 3 years is required to keep the trees in bounds

and prevent the breakage of branches. It is also equally important to know that there is no other method of stimulating the production of this 1-year-old fruiting wood back toward the center of the tree except by heading back the branches.

Very little pruning of this kind will be needed on vigorous 5-to 7-year-old trees. With older trees, however, that begin to slow down in growth to less than 12 inches annually heading back may be needed. The cuts should, if possible, be made to side branches in 2-and 3-year-old wood. Shortening back 1-year-old wood only is not likely to stimulate the renewal of fruiting wood far enough back toward the center. Such cutting may also tend to produce a thick growth of shoots that may interfere with fruit coloring. Judgment and discretion are required in cutting and training to control the spread and height of the branches.

Trees four years old may bear worthwhile crops and are generally considered in full bearing at six and seven years of age. The amount and kind of pruning will depend a great deal on the prevalence of fruit buds at blooming time. Since the early crops are borne on the small twiggy growth on the scaffold branches near the center, this growth should not be removed.

There is always danger of injury to the fruit buds by both winter cold and late spring freezes and frosts. The bulk of the pruning in many commercial and home peach orchards is, therefore, delayed until the blooming period when the crop is generally safe from winter cold. The amount of pruning, both heading and thinning, but more particularly the severity of the heading, may then be regulated by the abundance of the bloom and the indications of a crop. In case a heavy crop is expected, the tree may be headed back more severely.

Getting Rid of Pruning Brush

The removal of the pruning brush from the orchard generally constitutes quite a problem for the average grower unless he is properly prepared for the job. Many different kinds of homemade brush burners, carriers and pushers have been developed from time to time by producers as the need arose. Manufacturers are also handling an implement known as the brush rake and brush shredders.

An implement similar to the old buck rake may be placed in front of a tractor and the brush pushed to the place of burning. Brush burners may also be constructed from old oil barrels split open, spread out, bolted together and placed properly on iron skids or wooden skids protected against injury by fire.

The Michigan Agricultural Experiment Station reports that a wooden rake, six feet long, two feet wide with 5 to 8 tapered teeth made of hard wood, and with wire braces extending from the handle to cross-bar makes a very serviceable tool for dragging the brush to the center of the row in preparation for the brush pusher.

CAUTION.—Where the orchard has been mulched with straw or other litter, the brush burner should not be used in dry weather on account of the risk of starting dangerous fires. Where the trees are close together and rather strong winds blowing, there is danger of fire damage to the trees.

THINNING THE FRUIT

When heavy crops are produced, proper fruit thinning in June should be practiced. Cold injury may reduce the set of fruit buds to such an extent that fruit thinning is unnecessary. But when trees are heavily loaded, thinning the fruits until they are about 4 to 6 inches apart leads to greater uniformity in fruit size and usually enables the grower to market the product more readily and at higher prices. Fruit thinning may also favor tree hardiness under good nutritional conditions.

Mechanical Methods.—Up until the occurrence of the labor shortage occasioned as a result of World War II, fruit thinning was done by hand. Then followed the so-called brush method. This consisted of elm, haw, oak or other tree branches of a convenient size and length tied to a stick in such a manner as to form a loose broom. The blossoms and young fruits were beaten or thrashed in the tree tops. Further efforts to meet the labor shortage and thin the fruits gave rise to the development of hose thinning. In hose thinning, limbs and branches were jarred by giving them a sharp blow with a 15 inch length of old rubber spray hose. Hose thinning gave results equally as good as hand thinning. Due to the saving in labor expense, this method of peach fruit thinning has received wide acceptance in commercial orchards.

Chemical Fruit Thinning.—Beginning with Elgetol several other chemicals have been used extensively in experimental fruit thinning investigational work. More recently some of the Hormone Chemical Sprays have shown considerable promise. At this time, however, specific recommendations cannot be made for chemical fruit thinning, although research indicates that chemical fruit thinning sprays may soon be a reality.

SPRAYING PROGRAM FOR PEACHES

Thoroughness in application is one of the most important essentials in spraying. The right materials must be applied at the right time and in the right way, otherwise poor results or injury may follow. Moreover, if the spray does not entirely cover all parts of the tree, foliage and fruit needing protection, is likely to be attacked. Additional information may be found on the prevention of insect and disease damage to these fruits and others in Chapter 16.

NECTARINE GROWING

Nectarines (Prunus Persica Var. Nectarina) are fuzzless or smooth-skinned peaches. Peach seeds when planted may produce nectarines, or seeds from nectarine trees may in turn grow peaches. Also, nectarine varieties may originate as striking variations or bud sprouts on peach trees when one or more branches bear nectarines and likewise when nectarine trees in a similar manner bear peaches. The shape, form and development of the trees do not differ materially. The only difference to the average observer would be the smooth skin of the nectarine fruit. Some believe

that the nectarine possesses firmer and drier flesh of a richer flavor than the peach. The size of the fruit is usually smaller than the peach.

Like the peach, there are freestone and clingstone varieties. Both may produce yellow, red and white fleshed fruits and they are adapted to similar soils and climatic conditions. The smooth skin of the nectarine may cause the fruit to be more susceptible to attacks of fungous diseases and the damage of the plum curculio that is generally responsible for wormy fruits of peaches and nectarines.

Some of the most important varieties are Stanwyck, Queta, Gold Mine, and Gower. In their order of ripening the following are suggested: Cardinal, Early Rivers, Dixie, Lord Matier, New White, Lippiatt's Late Orange, Gower, Humbolt, Queta, Stanwyck, and Spanish.

In general, the growing suggestions for nectarines are the same as those of peaches as the nectarine is a peach without fuzz or pubescence on the fruit. Whatever is said, therefore, about the growing of peaches applies equally well to nectarines. Nectarines are grown most widely in California. Their chief use is for dessert purposes. Packages on the markets consist of the peach box with egg case dividers. The fruit may not be well known to consumers and the demand may not be nearly as strong as for peaches. However, with those that are acquainted with its merits, nectarines may have a higher ranking than peaches.

APRICOT GROWING

The Apricot (Prunus Armenica) probably originated in western China. It must have reached southeastern Europe at an early date, as Pliny and others mention the fruit in their writing. The Mission Fathers in the 18th century brought the apricot from Spain to California. Also, the fruit was grown extensively in Virginia as early as 1720 according to reports.

The fruit of apricot trees is red or yellow in color. When mature, the skins are smooth, flesh firm and sweet, the seeds or stones are large, smooth and flat, and they are generally freestones. The bark of the trees is reddish in color, resembling the bark of both cherry and plum trees. Spreading, rounded and fairly low tree tops are formed. The leaves are round, ovate, and sharp pointed. Fruit flowers are borne single, appear before the leaves, and about 7 days earlier than the peach.

Fruit production figures for 1937-46 show that California produced nearly 92 per cent of the crop in the United States, Washington about 6 per cent and Utah 2 per cent. Scattered plantings for local markets and home uses may also be found in Oregon, Arizona, New York, Michigan and in other states.

The flowers of the apricot are about as resistant to spring cold as the peach, and the wood and fruit buds of some varieties may endure lower winter temperatures than those of the peach. Apricot culture is largely confined to the three states mentioned above, because the blooming period is so early that spring freezes and frosts elsewhere may prevent the setting of profitable crops of fruit. Although brown rot may be responsible for considerable losses, yet with proper and timely spraying, control is possible.

In California the Blenheim and Royal varieties seem to be used most extensively, while in Washington Moorpark and Wenatchee Moorpark are popular along with Tilton, Blenheim and Royal. One of the leading sorts in Utah is the Large Early Montgamet.

The cultural practices including spraying, pruning, fruit thinning, soil handling and fertilization are quite comparable to those of the peach. Like the peach, apricot varieties grown commercially are self-fruitful and do not require the growing of two or more varieties in order to secure cross-pollination and fruit setting.

ALMOND GROWING

Although the almond (Amygdalus communis) produces nuts for both home and commercial uses, it is in practically all other respects similar to the peach. The best evidence indicates that the almond originated in western Asia and was probably brought to Greece and North Africa later. Almond culture in North America is almost entirely confined to California where more than 100,000 trees are now growing.

The flowers and foliage are peachlike and the pit or stone is the almond nut of commerce. When the nut is mature, the comparatively thin, hard covering of the almond pit splits and frees the seeds or nuts. The almond is so much like the peach; the cultural needs including propagation, pruning, pollination, fruit thinning, spraying and soil improvement are basically the same.

Climatic Requirements.—Almond trees are among the first to bloom in early spring, consequently the late spring freeze and frost hazard may become an important problem even in California. Rainy and foggy weather during the spring and early summer may give rise to blossom and fruit infection by brown and green rot diseases. Brown stains may occur on the shells of the nuts under extended moist weather conditions. This mars the appearance and lowers the market value of the crop. With such unfavorable factors in mind producers endeavor to find as suitable climatic and weather conditions for the growing of the almond as possible.

Pollination.—Some of the important almond varieties are self-sterile and others are cross-incompatible. Insect activity is almost entirely responsible for pollination at blooming time. Furthermore, as blooming occurs early and when the weather is likely to be too cool for insects to travel any considerable distances, pollinizing varieties are often planted in adjoining rows. Also, differences in time of blooming may be wide among almond varieties. Two or more varieties are used in order to provide for cross-pollination facilities and to have at least two varieties blooming at the same time. Honeybees may be needed at the blooming period.

Culture.—If possible somewhat lighter and more sandy soils are selected for almonds than for peaches. Although more resistant to injury from dry soils than other stone fruits, the almond responds favorably to irrigation and summer rainfall. The nitrogen requirement may be higher than that of the peach, but in general good peach culture applies equally well to the almond. Pruning practices are similar, although somewhat lighter cutting is usually suggested than for the peach.

VARIETIES.—The chief variety for California is Nonpareil. Another variety of importance is I X L but the trees are not as productive. Still other varieties are found in commercial plantings. Some of these are Ne Plus Ultra, Texas and Drake. To a less extent Eureka and Peerless are planted.

Candy bar manufacturers have requested almond growers to produce for their requirements smaller nuts in order to fit the new-size bar. Fortunately the University of California was ready with ten new smaller types, for distribution to growers in 1951. The largest outlet for almonds is candy manufacturers. It is possible, therefore, that a so-called streamlined nut might boost the almond market considerably.

Chapter 8

The Culture of Cherries and Plums

LIKE the apple, peach, and apricot, the origin and introduction of the cultivated cherry and plum are shrouded in mystery. It is possible that both fruits had their beginning in the same general region as the other fruits. Early historians believed that these fruits grew in abundance in the region south of the Black and Caspian seas. There is also some evidence indicating that the wild fruits grew over much of the region now known as Europe.

KINDS OR TYPES OF CHERRIES

The cultivated varieties are divided into two main groups or types. First, the sweet cherry trees are usually large, tall-growing trees, pyramidal in form, blooming earlier than most fruit trees, and susceptible to winter injury. Second, the sour cherry trees are usually low-growing trees, and sometimes assume a bush-like form. The trees are hardier and are much more fruitful than the sweet cherry trees. Varieties of these two species, and hybrids between them, are grown in all the deciduous fruit production sections of the United States.

THE SOUR CHERRY
(*Prunus cerasus*)

WHERE SOUR CHERRIES ARE GROWN.—The growing of sour cherries in western New York and particularly in the Hudson Valley constitutes an important industry. In the western lake growing region of Michigan marked development of commercial sour cherry production has taken place fairly recently. Considerable acreages may be found in the upper and central Mississippi River Valley and the lower Missouri Valley sections. Rather extensive plantings in the Arkansas River Valley of Colorado and in more or less restricted areas of Wisconsin may be found. In Iowa, Missouri, Nebraska, Kansas and in the states eastward to the Atlantic Ocean plantings are common particularly in home orchards.

SOILS AND SITES.—In general, cherries of all kinds do better on the light and sandy or gravelly loam soils than on the heavy soil types. This is more true with sweet than sour cherries. Some of the most profitable sweet cherry orchards are found on soils that might well be classed as sands.

Sour cherries, however, are grown successfully on a great variety of soils. In home fruit plantings they may be found thriving in soils ranging from stiff clay to almost pure sand. However, the best results are usually obtained upon deep, fertile, well drained loams.

The site selected should afford good air drainage. To obtain this, it may not be necessary to make the planting on the highest or steepest lands. Frequently somewhat lower ground unobstructed by timber or hills may furnish ideal air drainage. This may be particularly true of broad, open valleys.

The sour cherry may be grown successfully over a wide area. It will thrive in many different soil types and is able to withstand heat, cold, and extreme dryness to a great degree. The trees are generally more resistant to the attacks of insects and fungi than other stone fruits. Cropping may be as regular as that of the apple. The trees are nearly immune to San Jose scale attack and usually require only two to four sprays during the spring and early summer for the protection of fruit and foliage against insects and diseases.

Cherries Respond to Good Culture.—It would be folly as a rule to plant trees without preparing to practice proper cultivation, fertilization, pruning and spraying. On fertile, well drained soil with good care, trees should be expected to fruit regularly and profitably after about four or five years. There is usually a strong local demand for cherries.

Root Stocks for Cherries.—Cherries are propagated on two kinds of root stocks. These are known as the Mazzard and the Mahaleb and are grown from seed. Mazzard is the name given to a wild or semi-wild type of sweet cherry native to central and southern Europe. The fruit of the Mazzard is small, black, astringent, and bitter. The trees reach great size and may live to be very old.

Sour, Sweet, and Duke types of cherries are propagated on both kinds of stocks. Nurserymen generally prefer the Mahaleb stock especially for the sour varieties because it is easier to bud successfully and to grow a salable tree than on Mazzard stock. It is also true that the Mahaleb root is hardier than Mazzard and less likely to be injured by winter cold. This is an important factor in cherry culture especially in central and northern states. The evidence seems to indicate that on heavy soils Mazzard stocks give the better results, while on typically gravelly orchard soils Mahaleb stocks are preferable.

Plant Good Trees.—It is false economy to plant inferior or low grade fruit trees. The best which can be secured are the most profitable. Clean, vigorous, healthy stock withstands transplanting better and develops into more profitable fruit plants than stunted, less growthy trees. The early life of the trees is very important. If neglected for a single year during this period they may be injured seriously or ruined.

SOUR CHERRY VARIETIES

Dyehouse.—The chief advantage of the Dyehouse is its earliness. It ripens its crop about a week earlier than the Early Richmond. The fruit is somewhat smaller than that of the Early Richmond and the trees are

not quite so productive. This variety may be worthy of a place in the home orchard where a variety earlier than Richmond is desired.

Richmond (Early Richmond).—The Early Richmond is considered the leading sour cherry of its season. The fruit is medium in size, mediocre in quality and ranks fair to good in attractiveness. The fruit is not in so great demand for canning and pie making as Montmorency.

Montmorency.—This variety takes first rank as the leading sour cherry grown in the United States. Its fruit is in demand on the chief markets of the country for both commercial and home uses. Like the Richmond, it is well adapted to a great diversity of soil types, and this makes the variety suitable for wide planting. The fruit stands handling well in harvesting, shipping and on the markets. The canned product is attractive. The many good qualities of this variety commend it as the best in its season. It is widely known as the best pie cherry.

English Morello.—This is the standard late cherry. The fruit is attractive in appearance, stands harvesting and shipping well, is resistant to brown rot and hangs on the trees after ripening. It is distinctly a canning, preserving, and cooking fruit. As it is so astringent, it is not suitable for eating out of the hand.

THE DUKE CHERRY

Duke cherries are hybrids or crosses between the sweet and sour cherries. Consequently, Duke cherries have some of the characteristics of both the sweet and sour varieties. They are generally as hardy as the peach and bear fruit as often. Since they occupy an intermediate place between sweet and sour sorts, they are worth while for both home and commercial plantings. In time of ripening the chief varieties are May Duke, Royal Duke, and Late Duke. Royal Duke is generally preferred, although the blossoming time of Late Duke is somewhat later and the variety is valuable for the northern sections.

Cherry Pollination Requirement

The pollen of fruit trees generally is of a sticky or waxy nature and is not spread widely by air currents. Insects, therefore, are largely responsible for carrying the pollen from blossom to blossom. In the spring at blossoming time the common honeybee is relied upon for cross-pollination. Good orchardists plan to have at least one strong colony of bees placed on each acre of bearing orchard during the blooming period.

In most years, both cherries and plums may be benefited by cross-pollination. Two varieties planted together in strips of three rows each or three varieties planted alternately in strips of two rows may help produce regular cropping. Three varieties consisting of two rows each should benefit most in securing a good set of fruit.

All the commercial varieties of sour cherries are usually considered self-fertile. In years when cold rainy weather prevails at blooming time, the set of sour varieties generally may be greatly benefited by facilities for cross-pollination.

Most varieties of hybrid or Duke cherries especially May Duke, Royal Duke and Late Duke, are self-sterile due to their hybrid nature. They should, therefore, be interplanted with the chief sour varieties. These are Montmorency, Early Richmond, and English Morello.

The popular varieties of sweet cherries are self-sterile. For example, such varieties as Bing, Lambert, and Napoleon are inter-sterile with each other. Strains of Black Tartarian, Yellow Spanish, and Black Republican generally yield satisfactory results as pollenizers for the different sweet cherry varieties. Honeybees may be needed.

THE SWEET CHERRY
(*Prunus avium*)

Where Sweet Cherries are Grown.—The sweet cherry is grown commercially and extensively in California, Oregon, and Washington. Considerable areas devoted to commercial plantings may be found in Michigan, New York and Ohio. For home use and some commercial sales the fruit is grown rather widely from Utah, Colorado, Kansas and Nebraska eastward to New York and south to Virginia.

Soils and Climate.—The sweet cherry is very exacting in soil requirements, lacks hardiness to both heat and cold and is susceptible to the attacks of insects and fungi. The trees bloom early and the developing fruit buds are subjected to injury by late spring freezes and frosts. This is particularly true in the central, east and northern sections of the United States that do not have the protecting influences of large bodies of water. In spite of these drawbacks, sweet cherries are grown for home and local market uses and may be expected to fruit about as often as peaches. Sweet cherries are worthy of trials especially in the sections mentioned above.

Varieties.—Seneca of the Black Tartarian type is rated as one of the best sweet cherries. Other sorts grown more or less widely are Gold, Wood, Tartarian, Napoleon, Lambert, Bing, Winsor, and Yellow Spanish.

THE PLUM

The plum varieties have a great range of flavors, aromas, and colors, as well as forms and sizes. Named and cultivated kinds are widely distributed. In general, the markets demand large-fruited varieties that stand harvesting and handling well, but in home orchards a wide selection may be made.

It is very essential that a properly planned and thoroughly executed spraying program be followed in the culture of plums. The chief insect enemy of the fruit is the curculio, and the most destructive diseases are *Bacterium pruni* and brown rot. Thorough and timely spraying, however, supplemented by good culture, will usually control these pests.

NATIVE AND JAPANESE HYBRID PLUMS

Native Plums.—Most of the native plums are inferior to the Domestica, Damson, and Japanese varieties. In fact they may be considered of com-

mercial importance in localities where only native plums are hardy and suitable for culture. Hardiness to cold and resistance to heat and freedom from diseases and insects are the chief advantages of many varieties of our native plums. The Wild Goose plum is an old, well known, hardy, productive variety and the only native American plum planted extensively. Other popular American varieties are Excelsior, Miner and Weaver.

Japanese Hybrid Plums.—These constitute a large group of varieties which generally bloom before most of the European sorts. Consequently, these are usually much more susceptible to frost injury than the better European varieties. In flesh texture and quality, the Japanese Hybrid plums are much like the American plums. They are not rated highly for either dessert or culinary purposes particularly when compared with the superior European varieties. A few of the leading varieties are Underwood, Omaha, Red Wing, Hanska, and Gold. Other hybrids such as Munson, Waneta and Superior are found of value in some districts.

The European or Domestica Plums.—The European plums are the oldest and best known. They also have the widest range in flavor, size, color and aroma. Moreover, their adaptation including hardiness and period of blooming make the group the most sought in areas where they can be grown successfully. A few of the varieties that seem promising for planting in central and south central areas are Stanley, Grand Duke, Gueii, Italian Prune, German Prune, and Shropshire Damson. Still other sorts that might be used for home requirements and in trial plantings for commercial purposes are President, Yellow Egg, Moore's Arctic, Arch Duke, Pacific, Bradshaw, French Prune, Damson, Silver Prune, and Green Gage.

Fruit Station Varieties.—On the grounds of the Missouri State Fruit Experiment Station at Mountain Grove, 125 different varieties of plums of the three groups, European, Japanese and American, and their hybrids have been studied carefully for many years. Susceptibility to disease, quality of fruit, tree growth, hardiness of fruit buds to winter cold, and productiveness were given special attention.

The varieties recommended for planting apply particularly to the Ozark region and similar climatic sections. They are listed in order of ripening and the following is quoted from Bulletin 31, October 1942, of the above station:

First Choice		Second Choice	
Munson	Hybrid	Hanska	Hybrid
Red June	Japanese	Gueii	European
Underwood	Hybrid	Moore's Arctic	European
Gold	Hybrid	Burbank	Japanese
Maynard	Hybrid	Yellow Egg	European
Ember	Hybrid	French Prune	European
Stanley	European	Albion	European
President	European	Pond	European
		Monarch	European

PLANTING AT PROPER TIME

Cherries.—In former years, cherries and other stone fruits were usually planted in the spring. Cherries were believed to be the most difficult of

the orchard fruits to transplant successfully. Often from one-third to two-thirds of the trees died when set in the spring.

For the central and south central areas of the United States, experiments have shown that late fall or early winter is the best season for setting both sour and sweet cherry trees. Late fall planting of sour cherry trees, at the Missouri Experiment Station, has uniformly resulted in a good stand. Those set in the fall have usually transplanted as successfully as apples or other fruits.

Plums.—The Japanese varieties and other slightly tender species of the plum are subject to winter injury toward the north and are more safely set in the spring. American and European plums, however, benefit from late fall and early winter planting about as much as apples and pears of similar climatic sections.

Preparing the Soil for Planting

Well-drained, typical fruit soils may be prepared for orchard setting by deep plowing and thorough harrowing or disking as for potatoes, corn, or wheat. Thoroughly prepared, friable, and loose soil in good working conditions grows much better trees during the first few years than unplowed or poorly cultivated land.

Planting Practices

Both cherries and plums are spaced at different distances. This may be due to variations in soil fertility, varieties, pruning practices, habits of growth and climatic conditions.

Spacing distance between trees therefore may range from 20 to 24 feet for plums, 24 to 30 feet for sour cherries, and 28 to 32 feet for sweet cherries. Experimental evidence has proven that even wider planting distances might be more satisfactory.

On fairly level or sloping land the square system of planting the trees is still popular. Where there is danger of soil erosion on steep slopes, it is obvious that the trees should be planted on the contour. It is important that the usual care and suggestions be followed in the transplanting work.

Care of Young Orchard

Soil Management.—Regardless of soil types, the particular fruit section, or the kind of fruit grown, good orchard practices are necessary for a permanent soil management program. These consist of the maintenance of an adequate supply of organic matter, the presence of nitrogen in sufficient quantities, and the control of run-off water to check erosion and conserve the moisture supply.

The organic matter of the soil acts as a storehouse for moisture and nitrogenous compounds. With its gradual depletion, the nitrogen disappears and growth is reduced. Constant tillage tends to reduce or "burn out" the humus supply. The cultural practices, therefore, that make

nitrogen most rapidly available, at the same time most rapidly depletes the total supply. To maintain the soil organic matter, manures or cover crops must be worked into the soil from time to time.

Young cherry and plum trees when cultivated may grow twice as fast as similar trees in sod without cultivation. Moreover, the yield of bearing trees, under cultivation, is often double that of comparable trees growing in sod with no cultivation or fertilization.

Manure.—Manure not only acts as a fertilizer to supply fruit trees with available nitrogen but it improves the tilth of the soil. Also through the humus supply, the water-holding capacity is improved, and erosion and injury from drought are reduced. If sufficient manure is not available and even where it is plentiful, supplementary applications of commercial nitrogen fertilizers are helpful in promoting growth.

Commercial Nitrogen.—The chief substitutes for manure are nitrate of soda, sulphate of ammonia, calcium cyanamid, and ammonium nitrate. These commercial products contain much larger percentages of nitrogen than are found in manure. They are also far less bulky, and easier to transport and handle. Sodium nitrate contains 15 to 16 per cent nitrogen, depending upon methods of preparation, while ammonium sulphate contains about 20 per cent nitrogen, cyanamid 21 per cent and ammonium nitrate 32 per cent. From these percentages, the grower finds that only about three-fourths as much sulphate of ammonia and cyanamid or one-half as much ammonium nitrate are needed as nitrate of soda for the same amount of nitrogen. Spring applications of chemical fertilizers are much more effective in increasing growth than manure applied at the same time. This is because most chemical fertilizers are more readily and quickly available to the tree roots.

Amount of Fertilizer to Use.—The amount to use per tree depends upon the size and age of the trees and the cultural practices used. For sod orchards, about one-half pound for each year of age, is customary while in cultivated orchards only about half that amount is needed.

Young fruit trees even when planted on only moderately fertile soil, may be maintained in good vigor without using nitrogen fertilizers by proper cultivation of the soil and the application of manure or the growing and plowing under of leguminous green manure crops. If the land is kept in sod with ring or strip cultivation, then the trees should be fertilized at the rate of about 8 ounces of a 20 to 30 per cent nitrogen fertilizer per year of age of trees till they are 4 or 5 years old. At this age cherry and plum trees may be producing crops. For good growth and fruiting, applications of nitrogen fertilizers at the rate of 3 to 5 pounds per tree should be continued in most orchards.

Why and How to Prune

If the young trees are properly pruned at planting time they do not usually require severe pruning during the first two or three years of growth. The so-called corrective pruning during the first few years in the orchard is done largely to thin out interfering or competing branches, and since such cutting need not be severe it does not delay bearing materially or

reduce the size of the trees. Severe or heavy pruning, however, does delay the time of bearing.

Pruning is necessary to correct the shape or form of the tree and thereby to develop strong branches for carrying a heavy load of good colored fruit. Beyond this, however, severe cutting should be avoided. Light cutting each year keeps the branches properly spaced and in balance, but even this should be reduced to a minimum as the trees come into bearing.

FIG. 19.—Eight-year-old Montmorency cherry trees growing in adjoining plots. No fertilization was given. Moderate pruning was practiced on both plots. Plot 1 was cultivated 4 times each spring and summer after planting. No cultivation was given Plot 2 but the vegetation was cut each year during the latter part of June and the clippings were left on the ground.

Good fruit production started on both plots when the trees were 5 years old. After 10 years of this culture, the trees of Plot 1 were about twice as large as the trees in Plot 2. In the cultivated area Plot 1, the trees produced more than twice as much marketable fruit as the trees in the uncultivated land, Plot 2. (Mo. Agr. Exp. Sta.)

Pruning Sour Cherry Trees

The sour cherry tree is pruned to both the Open Head and Modified Leader. Either system may give satisfactory results if carried out properly. The object should be to train and grow spreading tree tops, sufficiently open to allow sunlight to enter. In fact, the tree tops should be kept open enough to admit sunlight to all parts of the interior; otherwise the fruiting branches and spurs die out toward the center and fruit production is confined to the outer portions of the trees.

Pruning Young Trees.—One-year-old trees, which are usually straight whips, require little or no pruning. However, since sour cherry trees do not start growth readily from lateral buds, under conditions comparable to the central and south central states area heading back of branches should be avoided. If two-year-old trees are planted all but three or four of the strongest and best distributed branches are removed close to the main stem. Those left are the permanent ones and are not headed back. They should be well distributed around and up and down the trunk and spaced as much as 5 or more inches apart if possible. The lowest main branch may be left at a height of 12 to 16 inches from the ground.

In training trees to the Modified Leader type, they are grown for the first few years as typical leaders. To produce this type of head, the main stem or the highest branch located near the center is allowed to grow a little faster than any of the lateral side branches. The Modified Leader is thus formed by adding a length of about 12 to 18 inches each year depending on growth, of the main stem. When the trees have reached sufficient height the leader or main stem is removed, if necessary, by cutting to a side branch of about the same size as the branch removed.

After the first 3 to 5 years, the trees may be treated as open center trees. Consequently the term "delayed open center" is frequently used in this connection. A comparatively large number of scaffold limbs are developed but the trees are not so tall as to prevent thorough spraying or economical harvesting and pruning.

Pruning Bearing Trees.—After the trees come into bearing, care should be taken to keep the tops and sides thinned sufficiently to allow the fruit spurs to develop properly and be productive. The tendency of sour cherry trees is to form a canopy of twigs and branches so thick that little sunlight penetrates to the interior. Without thinning and opening up the tops, much of the fruiting wood toward the center dies from a lack of food materials manufactured by the leaves in sunlight. In general, the pruning of bearing sour cherry trees should be light and of a corrective nature. It may well consist of the removal of dead and weak wood, and thinning of thick clusters of branches.

Pruning Sweet Cherry Trees

As in the case of sour cherries, the sweet cherry tree may be pruned to either the Open Head or the Modified Leader type. It is generally easier to prune to the Modified Leader type than the sour cherry. Some modification of

the Central Leader is required as many varieties tend to grow rangy with strong upright branches. The trees usually attain somewhat larger size than sour cherries, but at planting time are pruned and trained like the sour cherry.

When the trees come into profitable bearing it is not necessary to thin out or cut back much to admit sunlight, because the largest percentage of the crop is borne laterally on spurs. As trees grow older, however, they become less productive and vigorous. To stimulate the growth of new branches and new fruit spurs then and for general invigoration, somewhat heavier pruning may be done. This should consist of thinning out the tops and sides and cutting back the upper limbs to outward growing branches of about the same size.

Pruning Plum Trees

Usually young plum trees produce fruit buds on shoots which gradually give way, as the trees grow older and less vigorous, to the development of fruit buds on spurs. The Japanese plum however, is more like the peach in that it also produces fruit buds laterally on one-year-old wood. This is true to a greater extent on Japanese than on other kinds of plums, though all have a tendency to bear considerable fruit on spurs.

In plum culture, it is better to prune too little than to prune too much. Though apple trees may recover from severe cutting, plum trees may never recover. Trees should be pruned when young so that well-arranged scaffold branches may be developed as in the case of the cherry trees. Bad crotches should be prevented and symmetrical tops encouraged.

European varieties are usually trained to the modified central leader type while the Japanese sorts follow the Open Center system. The usual methods of training, pruning, and shaping the young trees should be practiced to develop branches able to carry heavy loads of fruit without breaking.

After bearing age is reached, pruning should become much like that for sweet cherries. Japanese plums are usually pruned a little heavier than other plums. This seems necessary to produce better-shaped trees, prevent breakage of branches, and to encourage the profitable production of fruiting wood. The heavier cutting consists of thinning out slender weak branches and cutting back strong upright growths to produce more spreading trees. This may be especially helpful with the Burbank variety.

Spraying

Complete information dealing with sprays and spraying practices for both home and commercial growers of cherries and plums may be obtained upon request from the State Agricultural Experiment Stations. In as much as the spraying chemicals for fruits may change from year to year, it is essential that the producer keep in touch with the Station in order to be fully informed as to the best materials to use as sprays, when to make the applications and the kind of spraying equipment that may be needed. General information on spraying, however, including suggestions for spraying cherries and plums may be found in Chapter 15.

Chapter 9

Growing Strawberries

THE strawberry is often termed the perfect fruit. It is one of the most generally grown crops common to the United States. The fruit is classified in the genus *Fragaria*, a member of the order *Rosaceæ*. The technical or Latin name *Fragaria*, refers to the fragrance or odor of the berries.

Strawberries succeed when grown upon many different soil types and under a vast diversity of climatic conditions. They are generally sure croppers as the spring bloom may extend over a period of about 2 to 3 weeks. Commercial varieties adapted for handling and shipping and other sorts less suitable for these purposes but possessing excellent flavor and aroma for home uses may be found in all sections of the country. It has long been rated as an early, profitable, cash crop, meeting the demands of producers, buyers, and consumers. The plants come into full bearing the year following planting and may continue to bear crops for one or more years.

Growing practices fit well into most farm crop rotations. The expenses for starting a strawberry planting are very conservative when compared to the beginning of other farm crop enterprises. Equipment such as plows, hoes, disks, harrows and the like are suitable for use in growing strawberries. The only cash outlay may be cost of plants for setting. Furthermore, all members of the family may engage profitably in the project.

Strawberry fruits are highly perishable. The season of harvest may last from 2 to 3 weeks. Picking, handling and processing in May and June must be carried out with dispatch for best results. The berries may be the first fresh fruit to appear on the markets and in the home in the spring. Strawberries, therefore, are usually in demand on account of their attractive appearance, spritely flavor and pleasant aroma. No other fruit excels in these considerations. If there is money with which to buy fruits, strawberries are sure to sell at profitable prices when compared with other crops.

VARIETIES

There is no one best variety of strawberries that can be recommended to the exclusion of all others. Most of the newer varieties have been developed for specific uses or conditions and are usually very limited in adaptability. The wise grower will observe for a few years an unknown kind of fruit in his community or set only a few plants before making an extensive planting. Also, commercial growers should not change varieties until most of the growers are willing to change since successful marketing

may depend largely upon being able to ship solid car or truck lots of a single variety.

A desirable strawberry variety is productive, a good plant maker and resistant to damage from drought and disease. Varieties for home use should have a high flavor, and good dessert quality. For commercial purposes satisfactory handling and shipping qualities, good size, attractive appearance, and firmness after processing are needed.

In general, adapted varieties most suitable to the particular region or section are being planted. Toward the South the Blakemore, Missionary, Klonmore, Massey and Klondike are popular. In Missouri, Kentucky, Tennessee and northwest Arkansas, a considerable acreage is still being planted to the Aroma variety for commercial shipments. Howard 17 (Premier) is grown widely especially for home uses in Kansas, Nebraska and east to New Jersey and north to southern Maine. On the West Coast from southern California to northern Washington, the Marshall variety is grown extensively, chiefly on account of its adaptability for processing including quick freezing to meet commercial demands.

Some new varieties now being listed include Armore, Temple and Sparkle. Resistant to Red Steele Disease are Robinson (home use), Fairland, Vermillion and Empire. In choosing varieties, whether for the commercial markets or home uses, it is important that the producer select the kinds that have proven most profitable. Information on local varieties may be obtained from the State Agricultural Experiment Stations, County Agents, successful growers and others. Since strawberry varieties may be sensitive to development and production due to soils, climatic conditions, etc., it is particularly important that a thorough investigation of varieties adapted to the particular area be studied before making large plantings.

Principal Strawberry Varieties in The United States in Order of Importance, Based on Established Acreage in 1946 (Adapted from Darrow and Waldo, U.S.D.A.)

Rank	*Variety*	*Total Acreage Per Cent*	*Rank*	*Variety*	*Total Acreage Per Cent*
1	Blakemore	34.0	9	Fairfax	2.0
2	Howard 17	12.0	10	Lupton	2.0
3	Marshall	11.0	11	Redheart	1.0
4	Klondike	7.0	12	Beaver	1.0
5	Klonmore	7.0	13	Dorsett	1.0
6	Aroma	6.0	14	Massey	1.0
7	Missionary	4.0	15	Robinson	1.0
8	Catskill	4.0		Other Varities	6.0
				Total	100.0

The table above is significant in that the summary based on established acreage represents briefly the chief and important varieties grown in the United States in 1946. Furthermore, it is believed the ranking and acreage throughout the country has not changed materially since the date mentioned.

SOILS, LOCATIONS AND SITES

Soils.—Most varieties do better on light sandy, gravelly or stony soils than on clay, heavy or wet soils. New land is often preferred on account of the increased yields and because there are fewer weeds to fight and less cultivation required. For best results, a well-drained fairly light, moisture-holding medium fertile soil is generally desired.

Location.—The commercial strawberry field that is conveniently located near a town or city has important advantages. Pickers are more easily obtained and both transportation and marketing problems may be simplified.

Sites.—Favorable sites afford good air and water drainage to somewhat lower levels. Low areas or "frost pockets" more or less surrounded by heavy timber or hills that slow up good air movement should be avoided, if possible. In selecting the site for the field, however, it is not necessary to establish the planting on the highest or steepest land. Sites of medium elevation and gently rolling may prove very satisfactory. Proper air drainage may be important in preventing frost injury at blossoming time.

WHITE GRUB AND WEED CONTROL

Before planting strawberries on sod land, and particularly land which has grown lespedeza, a crop requiring clean cultivation for at least two years should be grown. This is for the purpose of destroying the white grub which may live over in the soil for two years. Cultivation helps to destroy the seeds of weeds, grasses and prevents their reseeding. Such tillage permits the use of manure, commercial fertilizers and cover crops to build up the organic matter and mineral content of the soil. Old land may be made as productive as new ground, by building up the fertility and organic matter and maintaining it. Most growers agree that, if the weed and grass problem can be solved, old ground may be made satisfactory for the growing of strawberries.

EVERBEARING STRAWBERRY VARIETIES

The perpetual or everbearing types are grown like other varieties. For satisfactory production they require a fairly fertile soil of good texture with an adequate and well distributed moisture supply. Where irrigation is used, these varieties are much more likely to succeed. The everbearers may be preferred by some home producers, while the standard sorts are best for commercial purposes and most home uses.

Early spring planting is suggested. Blossom buds that begin to form soon after growth starts should be picked off until midsummer. If early blossom buds are not removed they tend to prevent runner plant growth and reduce berry yields in late summer and fall. Blossoms developing later, if allowed to grow, may produce fruit during the late summer and fall and until frosts occur.

As the so-called everbearers, or fall bearing strawberries do not produce a large number of runner plants, they may be planted in rows from 30 to 36 inches apart with the plants spaced in the row from 15 to 20 inches apart. It is important that the soil about the plants be given timely and thorough cultivation especially following rains.

A mulch consisting of wheat straw or similar material sufficient to conserve moisture and keep down weeds and grass should be placed around the plants shortly before the fruit begins to ripen. The mulch is also needed to keep the berries clean or free from soil particles. Winter mulch materials are applied just before the first hard freeze, as for other varieties. The mulch is removed sufficiently early in the spring to permit early plant growth.

Several different varieties are used successfully. Some of these are Rockhill (Wayzata), Gem, Gemzata, Mastodon, Progressive, and Green Mountain. For the central states' conditions, Rockhill, Superfection, Brilliant and Red Rich generally succeeds well. The last three varieties listed are new and are being tried out by growers and experimenters.

PLANTING A NEW FIELD EVERY YEAR

Planting new berry fields every year should reduce damage from insects and diseases. Such a system, conscientiously followed, should also tend to stabilize production, increase yields, improve quality and increase returns. On the other hand, it may be said that planting every year will run up costs of production. If the expense of renewing the field after harvest is considered, production costs will be raised little or none. Moreover, the larger yields, higher quality of berries and less likelihood of damage by pests from fields fruiting only once should largely offset the expense of planting every year. During very dry summers, however, early spring plantings or fall plantings may not develop as good a row for production ahe following year as old fields or patches properly renewed and cultivated tfter harvest.

Additional study and due consideration has convinced a large percentage of successful commercial strawberry growers as well as home producers, that the planting of a new field or patch every year will usually pay good returns. Quality strawberries are always in demand. It is common knowledge that no other factor in the growing operation is likely to mean so much in promoting high quality as berries picked from plants producing their first harvest. Furthermore, the first crop usually gives the highest yield, while pickings in the second, third and later years generally fall off markedly in both quantity and quality as long as the old planting is continued.

Season of Planting

Early Spring Planting.—As a general rule, strawberry plants should be set as early in the spring as the weather permits and the ground can be worked. For the South Central States, the plants should be ordered early so that they may arrive during late February or the first part of March.

In the central and northern sections the plants should be available for planting during the latter part of March or first of April. In the Southern States plantings are made at various times depending upon the purposes and needs. Summer and fall plantings may be advised in some districts, while winter and early spring setting may be followed in other sections to meet the needs and purposes of producers.

Temporarily, the plants may be held for a few days in a cool cellar, or much longer if held in cold storage or heeled-in outside. Plantings made later than the first of April in the Southwest frequently fail to make a good row. Early planting, therefore, is strongly recommended.

Late Fall Planting.—Commercial growers in southwestern Missouri and northwestern Arkansas have found late fall setting to be profitable. Their experience has been confirmed by experimental work done on the University of Missouri's horticulture experiment field near Monett. In general, it may not be profitable to set strawberries in the late fall in other sections unless the climate and soil conditions are comparable to those of southwest Missouri.

November set plants generally produce a better row and give increased yields since they get off to an earlier start in the spring. Based upon experimental work for southwest Missouri conditions, about the middle of November appears to be the best date for fall planting. To prevent winter injury, a mulch should be applied before the first hard freeze. Only enough straw to cover the plants is needed. The mulch is removed and cultivation is started in early spring as soon as the soil can be worked. The grower also generally has more time and better weather for preparing the ground and setting the plants in the late fall than in the early spring.

It should be noted, however, that November planting is suggested only for conditions comparable to those of southwest Missouri. Late fall settings in central Missouri (Columbia) repeatedly failed to show a profit. Furthermore, late fall plantings do not produce a crop the next year. In fact, it should be emphasized that the late fall set plants should be treated like early spring set plants.

Selecting Planting Stock

Medium large, sturdy, vigorous, one-year-old plants generally give best results. The one-year-old plants, usually called new plants, give quicker and stronger growth than older ones and a larger percentage of them grow. The large plants usually stand transplanting better, start forming runners or new plants more quickly, and are more resistant to diseases and insects than small and less thrifty ones.

Care of Plants on Arrival

As soon as the plants are received, examine the roots to see if they are moist. If they are not, moisten them at once and keep them so in a cool place away from the sun until transplanted. The roots should never be exposed to the drying action of the wind and sun. When planting, the

roots of the plants may be kept in a bucket or tub partly filled with water or they may be covered with damp packing material or wrapped in damp gunny sacks.

Pruning Before Setting

If the tops of the plants are large, pruning may be helpful in securing a good stand. Part of the leaves are removed to reduce transpiration before the roots become established in the soil. The amount of pruning will depend upon the season of the year, the size of the plants, and the condition of the weather and soil at planting time.

Early in the spring when the leaves are small and few in number, little or no pruning is required. When the plants are older and the time of planting later, all but one or two of the smallest leaves in the center should be removed by cutting the leaf-stems near the crown of the plant.

The roots are usually cut back from one-fourth to one-fifth of their length, leaving them about 4 or 5 inches long. The removal of a portion of the root system may permit better spreading of the roots and prevent doubling over and twisting when planting.

Spacing or Planting Distances

The average spacing and planting distances of commercial growers using horse or power machinery for cultivation are from 3 to $3\frac{1}{2}$ feet apart in the row and 4 feet apart between the rows. For hand cultivation the plants may be set 18 to 24 inches apart in the row, with the rows spaced 3 feet apart. On small areas for home production, distances may be reduced considerably. Spacing 18 to 24 inches in rows $2\frac{1}{2}$ to 3 feet apart may prove satisfactory with good thinning. Heavy plant producing varieties like Blakemore require more space unless properly thinned than moderate to light plant producing sorts.

Number of Plants Needed in Setting

The number of plants required for an acre may be obtained by multiplying the number of feet between the plants in the row by the number of feet between the rows. This will give the number of square feet occupied by one plant. Then divide the number of square feet in an acre, which is 43,560 by this sum. The quotient will be the number of plants needed for one acre. In order to have enough plants to replace those which die or do not thrive after being transplanted for a period of about three weeks, some growers order about one-tenth more plants than required to set the field. With the plants set $3\frac{1}{2}$ by 4 feet, 3,111 would be required for one acre. About one-tenth more for loss and replacements gives 3400, the number usually needed for one acre, planted $3\frac{1}{2} \times 4$ feet.

How to Set Strawberries

It is important that strawberry plants be transplanted to the proper depth. An opening in the prepared soil should be made just deep and wide

enough to accommodate the roots when spread slightly and to allow the crown of the plant to be level with the ground when the soil has been thoroughly firmed about the roots. If the crown extends too far above the surface of the ground, the plant may dry out and die or become unprofitable.

Whether the plants are set by hand or by machine planters, the soil should be well prepared and the transplanting work should be given careful attention. A good stand of plants is required for success.

The most important points to remember in transplanting strawberries are to thoroughly firm and compact the soil around the roots of the plants and, when the work is finished, to have the crown or growing point of the plant just level with the top of the soil.

Training and Spacing Runner Plants

The early runner plants should be saved and developed as rapidly as possible. This is true because the plants formed in July and August produce more fruit the following year than those formed later. It is also very important that the plants be carefully spaced and encouraged to root rapidly in order that they may grow the maximum number of leaves and healthy, vigorous crowns for the next year's crop. Rooting can usually be facilitated by pressing gently the young plants into the mellow soil and pulling a thin layer over the runners.

From four to six plants per square foot are usually sufficient for good yields but, where early, strong runner plants can be developed, three or four plants per square foot may even give better returns. In general, it is not profitable to go to great trouble and expense in spacing the plants. In hoeing and plowing, however, the grower should space the early runner plants about 6 inches apart to be assured of the most profitable yields of high quality berries. The width of the spaced row may vary from about 12 to 24 inches.

Cultivation

On old ground, particularly, the plants may require cultivation at intervals of ten days or two weeks from the time they are set until vegetation is killed by frost in the fall. The number of plowings and hoeings will depend a great deal upon the amount of rainfall and the prevalence of grass and weeds. It is not necessary, however, to cultivate more often than is required to keep down grass and weeds. Shallow cultivation also generally gives better results than deep plowing or stirring of the soil. In fact, deep cultivation in late summer and early fall may do more harm than good by destroying plant roots. It is important, however, that the field be kept free from grass and weeds at all times.

Blossom Removal After Planting

Fruit production is a great drain on the plant. For this reason, all blossom stems should be pinched off during the first year following trans-

planting, in order to produce many strong, vigorous plants. If the plants are allowed to set fruit, the yield of the current year and the next year is likely to be small and unprofitable. The blossoms may be pinched off in a special operation or when plowing and hoeing.

Preparing Land in Advance for Strawberries

By plowing under barnyard manure and such leguminous crops as cowpeas, soybeans, vetch, clover, or alfalfa, both humus and nitrogen are added to the soil. Non-leguminous crops like wheat, rye, and barley may also be plowed under for the purpose of building up the water-holding capacity of the soil than it is to add fertility in the form of nitrogen. Strawberries require large quantities of soil moisture in maturing a crop but only a moderate amount of nitrogen.

With all these soil improving crops, much greater yields may be produced for plowing under by applying a high analysis complete fertilizer during seeding operation at the rate of 500 to 700 pounds to the acre. Proper seed inoculation for the legumes is also very helpful in securing good stands. Such green manure crops will greatly increase the volume of organic matter to be disked or plowed into the soil.

Use of Commercial Fertilizers.—Where the soil fertility has been kept up by the rotation of crops, the growing and plowing under of leguminous or non-leguminous crops and barnyard manure, it is usually unnecessary to use commercial fertilizers following planting. Fertilizers and manure are generally of more value to strawberries if they are used properly in growing crops preceding strawberries. Their use in the strawberry field may actually be detrimental rather than a benefit to the crop. Where the soil will grow good crops of potatoes, corn or wheat, usually a profitable crop of strawberries can be produced without fertilization.

Depleted or poor soils should be fertilized at planting time. A complete fertilizer like 4-16-4 or 4-12-4, or a similar combination at the rate of 500 to 800 pounds per acre may be drilled or cultivated into the top soil. The fertilizer may also be cultivated into the soil between the rows. Side dressing applications of less amounts may be made at planting time. On old fields where only one application is made, August or early September is likely to give the best results.

Caution.—Where a commercial fertilizer is used at planting time or around the plants when the fields are renewed it is important in order to prevent injury by burning that the fertilizer be well mixed with soil before being worked closely around the crowns or roots of the plants. Nitrate of soda or ammonium sulphate may also seriously burn the leaves and stems of the strawberry if applied directly to them. This will be particularly true when the foliage is wet.

Working Out Fields or Patches After Harvest

A stand of plants in a row approximately 24 inches wide with about eight to ten plants per square foot is generally needed for good yields. If

the plants are allowed to become much thicker, yields per plant are likely to be lessened. If matted rows are cut down to a width of 10 inches soon after harvest or in July, the grower may expect a reduction in yield the following year.

In the renewal of fields and patches immediately after harvest, therefore, the object or purpose should be to retain enough old plants for a satisfactory row as described above. Where there are not enough old plants to provide for this, good cultivation and fertilization may hasten the production of new runner plants and if these are formed and established no later than August or early September in southern sections they may prove to be fairly productive the following spring. It is important that the early production of runner plants be encouraged. On poor soils, the use of 300 to 400 pounds of a complete fertilizer in the spring renewal operations and

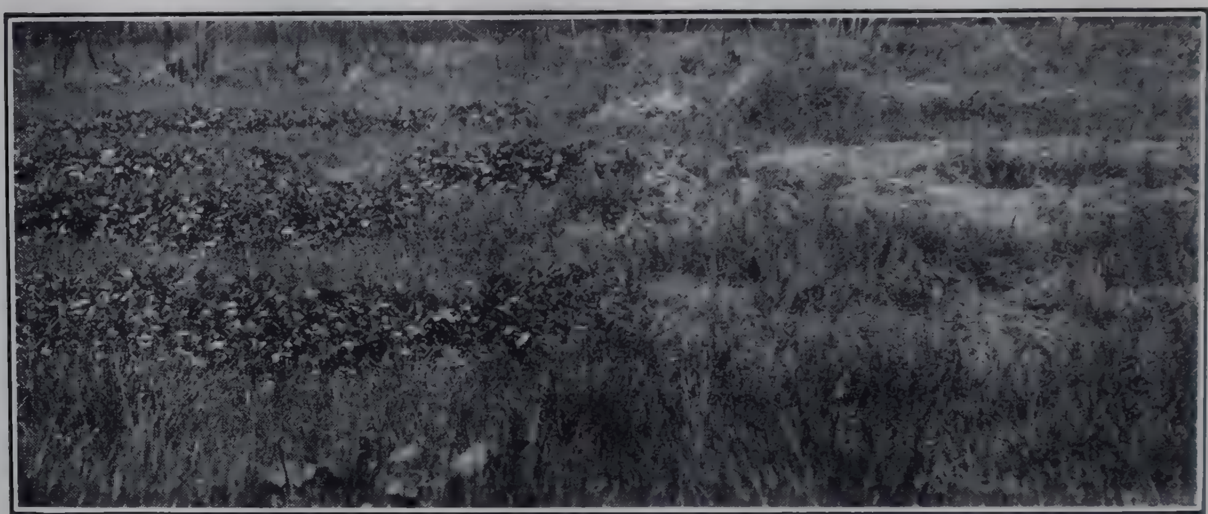

Fig. 20.—Strawberries growing in a home orchard. The plot on the left was renewed after harvest last year by cultivation and thinning the plants to stand about 6 to 8 inches apart. The work was started soon after fruit harvest. Cultivation to keep down weeds and grass was continued until fall. The plot on the right received no care after harvest. Nearly all the plants died and practically no fruit was harvested the following season. However, as the strawberry bloom indicates, a good crop of high quality berries was harvested from the end of the patch receiving good care. (Mo. Agr. Exp. Sta.)

an equal amount in late August or early September may give good results. However, rarely if ever will spring fertilizer applications prove profitable. Yields may be cut, softer berries produced and disease injury increased.

Removal of Leaves and Mulch.—The strawberry field should usually be mowed and raked immediately after the harvesting period. These operations will rid the patch of injured leaves, and assist in the control of fungus diseases and insect pests. A mowing machine with the cutter bar raised slightly in front may be used effectively for this purpose. After mowing, the leaves and mulch may be raked into windrows and removed from the field. This practice alone tends to increase yields.

Reducing Width of Rows.—The next operation, after removing leaves and mulch, may be to narrow down the old matted row to about 24 inches. This may be accomplished in a number of ways. One of the most common is secured by running twice between the rows with a one- or two-horse

cultivator. In this way the old strawberry row may be reduced to the desired width. Where horse or power cultivation is not employed the work may be done with hoes, spades or other implements. The plants may also be allowed to cover the whole area of the old row. Home growers may eliminate about one-half the old row and save the other half for fruiting the next year. However, in cultivating and spacing with plows, hoes or other implements, select wherever possible the healthy, one-year-old plants and leave them for fruiting instead of older ones. The young healthy vigorous plants may be more than twice as productive as the old plants the following year. It is important that good cultivation of plants and proper thinning if needed be continued until frost.

Mulching is Important

No variety of strawberry is immune to winter injury, although the damage may vary materially with the different sorts. The injury may cut the yield of the plants the following spring anywhere from about 10 per cent to as much as 50 per cent. Production is frequently reduced from one-third to one-half and the cause is often attributed to an attack of diseases and to the effects of drought, one or both.

Crowns and Roots Injured Early.—The plant crowns and roots may be injured early. Consequently, if temperatures drop to near zero or even 10 to 15 above during the latter part of November or in early December before the mulch is applied, great reductions in the strawberry yield may occur in the following year. This will be especially true if warm weather lasts until very late in the fall and is followed by a sudden drop in temperature. In such cases the damage is likely to be much greater than in years when cold weather comes on gradually. Under normal weather conditions the plants gradually become hardened and develop resistance to cold.

Time to Mulch.—To avoid injury by cold it will generally be found advisable to mulch the strawberry plants during late November or the early part of December in the Central States. Earlier mulching may be needed in northern sections and it may be made later in southern districts. In most cases it will be well to have the mulch on before the first hard freeze and not after. If the plants are growing rapidly as a result of good fall growing conditions, mulching should be postponed as long as possible. This is true because mulching is likely to injure growing plants. Also plant hardiness is usually being developed rapidly near the mulching period.

Study Weather Bureau Forecasts.—In most instances it will be advisable to place in the strawberry fields or on the borders early in November at least a part or all of the mulching material needed. Then watch the forecasts of the U. S. Weather Bureau, particularly during late November and early December. When temperatures of 15° F. to 20° F. or lower are predicted, it is highly important that at least a part of the mulch be spread over the strawberry rows. The ground is warm and only a light covering is needed for protection against injury. The remaining portion of the mulch may be spread as soon as convenient after the first cover is applied.

Mulching Material.—The most common mulching material consists of wheat straw, oat and rye straw, slough grass, leaves and strawy manure. Leaves alone are not as satisfactory as the other materials, because they lie closely together and pack down in such a way that they may tend to smother out the plants if heavy applications are made.

The mulch should be as free as possible from seeds. A growth of weeds or wheat will reduce yields during a dry spring, make picking more difficult and lower the quality of the fruit. Renewal after harvest is also more difficult.

The mulch material can usually be freed from seed by placing it in low piles around the edges of the strawberry field a month or so before it is to be used. The extra handling will sift out most of the seeds and chaff. Fall rains may wet such low piles and germinate most of the seed. The moist straw is easier to handle and stays in place better.

A mulch of from 2 to 4 tons per acre is usually sufficient and it should cover the plants from 2 to 2½ inches in depth. Toward the South lighter coverings or mulches are required. The mulch is to prevent cold injury to crowns and roots, conserve moisture, keep the soil cool and damp during the season when the fruit is ripening, prevent heaving out the plants in winter, facilitate harvesting operations, and keep the fruit clean at picking time.

Removal of Mulch.—The mulch above the strawberry plants should be removed sufficiently to uncover and expose the plants to sunlight and air, as soon as growth starts in early spring or shortly before. The mulch may be raked lightly between and around the plants and toward the middles between the rows. An ordinary hayfork is generally considered a satisfactory implement for this operation.

Uncovering the plants early in the spring as growth starts prevents delayed growth and the development of leaves and stems tender to frost if mulch removal is delayed. Also, the mulch around the plants tends to keep the berries at harvest time free from sand and earth. It helps to conserve moisture, keeps down weeds and grass, and if wet soil or dust is present the soil covering may facilitate picking and handling operations in both wet and dry weather. For home plantings especially, the mulch may be used to delay the blossoming period by allowing it to remain over plants somewhat longer.

Dust or Spray Strawberries as Blooming Starts

Dusting or spraying strawberries in old fields or patches as blooming starts may increase yields as much as 25 to 30 per cent. For success, it is important that the work be done timely, thoroughly and with the proper chemicals. Some of the harmful insects that may be destroyed are crickets, tarnish plant bugs, cutworms, flea beetles and crown borers. Apply dust or spray as blooming starts.

The dust may be prepared by using 1 pound of 50% DDT and 1 pound of 50% chlordane in 8 pounds of a filler such as wheat flour, talc, or dry lime sulphur. Small quantities of dust may be prepared from the dosages suggested. The rate of application is about 20 to 30 pounds of dust per

acre. In every case, the plants including leaves, stems and crowns must be well covered for effective results. Apply dust early in the morning while the dew is on, or late in the evening as dew is forming.

Some growers may prefer to use sprays and if thorough work is done, spraying should be equally as effective as dusting. In spraying use 1½ pounds of 50% DDT and 2 pounds of 50% chlordane in 100 gallons of water. Good spraying will require about 100 gallons of the liquid per acre. For 5 gallons of spray use ⅛ pound of 50% wettable DDT and ¼ pound of 50% chlordane. It is important that the dust or spray be applied just as blooming starts and that very thorough work be done.

Berries Benefit From Timely Irrigation

It is well known from study and observation that strawberries require tremendous amounts of water for their development and good fruiting. The need for water is greatest during the growing and harvesting season.

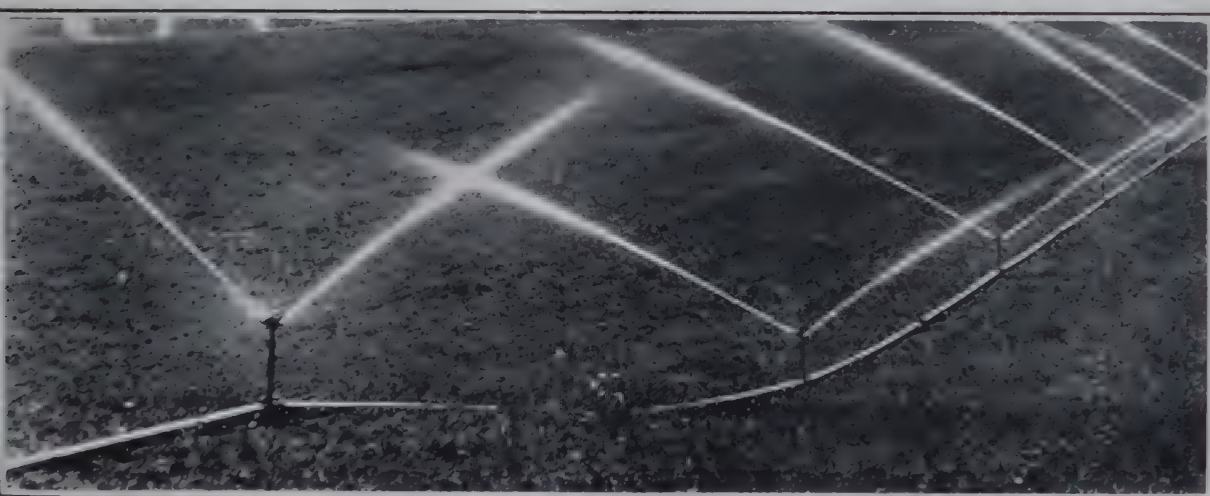

Fig. 21.—Portable sprinkler lines are light in weight and easily moved from one location to another. A minimum of equipment, therefore, is needed to irrigate large areas efficiently and economically. (Courtesy of Aluminum Company of America, Pittsburg, Pa.)

Strawberry plants show a lack of moisture by reduction in growth, blooming and fruit set and development. In fact, as every strawberry grower knows, a severe drought, a few weeks before harvest, may ruin the prospects for a paying crop. Dry weather at other periods may also effect growth and fruiting materially.

An abundant supply of water near the field is a requirement for irrigation to be practical and economical. Rarely is there a growing season when irrigation is not needed. Furthermore, in some years, irrigation is the practice that makes paying crops possible. The kind of irrigation most generally used is some type of the portable sprinkler system. The water is carried to the strawberry patch or field in pipes under pressure and it is sprayed out and falls like rain. The sprinkler system applies the water at a rate which the soil will immediately absorb. While the sprinkler

principle has been known for a long time, it did not become popular and practical in the humid sections for general uses until about five or six years ago.

Fig. 22.—Aluminum irrigation pipe, approximately one-third the weight of steel, brings ease of handling and reduces labor costs to sprinkler system. It is durable and withstands the rough treatment often received in the field. (Courtesy of Aluminum Company of America, Pittsburg, Pa.)

For the portable system, the complete unit may be moved during the irrigation of a field because the pipes are light and durable. They are the least expensive to install, but they may require more labor for the irrigation work. Soil erosion is prevented through the use of the sprinkler system. The water soaks into the soil about as fast as it is applied. Soils too porous for economical surface irrigation may be irrigated successfully by sprinklers. Also, the system may use about the same amount of water at the far end of the portable line as at the pump. Good use may also be made of a flow of water that would be too small for wise surface irrigation. Land-leveling is not required and steep slopes may be irrigated.

Chapter 10

Growing Grapes

THERE are many native species of grapes grown in the United States. However, the wild fox grape, *Vitis labrusca*, is responsible either directly or through crossing with the Old World Grape, *Vitis vinifera* for the so-called American grapes. On the East coastal plains and in the warmer parts of the South, the Muscadine grapes of the species Rotundifolia is found. Some of the most important varieties are Scuppernong, Misch, James, Flowers, Thomas, and Eden. In the western states, and especially in California, the European grape *Vitis vinifera* is the main grape of commerce, because the climate and soil conditions are well suited to its culture on a large scale.

AMERICAN GRAPES

Fox grape (*Vitis labrusca*) is the most important. It possesses the best flavor and is most attractive. This grape may be had in black, white and red fruited varieties. Both southern and northern forms of it are available and they are widely adapted to different climates and soils. Such well-known varieties as Concord, Niagara, Worden Catawba, and Delaware are typical. The pronounced musky odor and flavor of the berries gave rise to the name "Fox" grape.

GRAPES AS A FRUIT CROP

Grapes have many more advantages than are usually credited to them. In their growing regions, they are generally hardy, easily grown, and productive. In climatic adaptation, grapes show wide variations. They may be grown in almost every condition of soil moisture and dryness and of heat and cold. They may be propagated without difficulty and the plants are relatively cheap. Grapes come into full bearing in four years; their life is long under good culture, and the harvests are generally regular and abundant.

The grape is a sure cropper. This is true because the fruit is borne on shoots of the current season's growth. Furthermore, the nodes or "joints" on the canes of the past season's growth contain a group of three or more buds. If the first shoot from the primary bud is killed by frost or otherwise, a secondary bud may produce a new shoot. Should this be destroyed another fruiting shoot may even be produced. Secondary shoots, however, are only about one-fourth to one-third as productive as shoots arising from primary buds. Fruit production is still further reduced if secondary shoots are destroyed and third shoots are forced to grow.

Fruit and wood usually mature early enough in late summer and early fall to avoid injury by cold. The fresh fruit is usually popular and in demand at fair to good prices. Also large numbers of by-products are possible. Among them are unfermented grape juice, flavoring syrups, jams, jellies, wines, etc.

CHOICE OF VARIETY OR VARIETIES

Careful study of potential market outlets should determine the variety or varieties to be planted. For example, if the grape crop is produced chiefly for the manufacture of grape juice, Concord is the variety desired at this time. In fact, some grape juice concerns will accept no other variety.

Though not considered the most desirable variety for the fresh fruit market, Concord makes up the bulk of the handlings from the Central and Eastern States. The fruit is also excellent for processed products. The vines are hardy, vigorous, productive and fairly resistant to the attack of insects and diseases. The clusters and berries are of good size and attractive.

Concord has a tendency at times to ripen its fruit unevenly, but with good culture and proper pruning this fault may be largely overcome. It is self-fertile or self-fruitful and may be planted without reference to cross-pollination with other varieties.

Table Grapes.—Barry (black), Brocton (black), Catawba (red), Concord (black), Delaware (red), Fredonia (black), Golden Muscat (yellow), Herbert (black), Merrimac (black), Niagara (white), Portland (white), Seneca (white), Sheridan (black), Wilder (black), and Worden (black).

Red Wine Grapes.—Clinton (black), Ives (black), Norton (blue) and Sheridan (black).

White Wine Grapes.—Catawba (red), Delaware(red), Dunkirk (red), Elvira (white), Iona (red), Hanover (red), and Ontario (yellow).

Juice Grapes.—Chiefly Concord (black).

The varieties known as Barry, Herbert, Merrimac and Wilder are generally considered self-sterile and should be planted for best results in alternate rows with such self-fertile sorts as Concord, Niagara and Catawba. The self-fertile varieties, however, are usually planted in solid blocks for convenience in cultural care and harvesting.

PROPAGATION OF GRAPES

Well-matured canes of the past season's growth are secured in November or December. The canes are generally slightly larger than a lead pencil with nodes or joints about 5 to 6 inches apart. The cuttings are ordinarily 10 to 12 inches in length and include 3 buds. With the joints close together, more than 3 buds may be used. In preparing the cuttings, a slanting cut is made through or slightly below the basal or lowest bud. The cane is then usually cut about 2 inches above the third bud, counting the lowest bud as the first one. This method of cutting clearly distinguishes the lower end which is to be placed in the ground. The upper bud is to protrude

just above the soil when the cutting is planted. The newly made cuttings are tied in bundles of 25 to 50 for convenient handling and storage.

Storage of Cuttings.—Cuttings may be successfully stored in a cool, moist place until time for planting in the spring. Moist sawdust, sand, and peat moss are satisfactory packing and storing materials. The cuttings may be placed in a cool cellar, or in an outdoor mound or pit. If held in cold storage, a temperature of a few degrees above freezing is satisfactory.

Planting Cuttings.—Where only a few cuttings are needed they may be made early in the spring just before or just as growth is starting. When this is done, they can be stored temporarily or planted immediately. The cuttings should be planted early in the spring before root or top growth appears. If plantings are made after growth starts, the loss of cuttings may be considerable. Nursery rows 3 to 3½ feet apart are made in well prepared soil. Such rows or furrows, which are 8 to 10 inches deep, can be made with a plow or spade. The cuttings are placed about 6 to 8 inches apart in a slanting position along the smooth side of a furrow. Then the soil is packed firmly particularly around the base of each cutting so that the top bud is just above the soil.

Late fall or early winter preparation of the soil for spring planting usually produces the best results. The cuttings may then be planted early in the spring while the soil is too wet for stirring. If the ground is fairly smooth, the rows may be marked off 24 to 36 inches apart by stretching a string from stakes driven into the soil. Then the cuttings may be pushed into the moist soil by the side of the string about 6 to 8 inches apart, leaving only the top bud above the surface of the soil. This method of planting is generally more rapid and since the cuttings are pushed into the soil, the bottom parts from which root development starts are likely to be in close contact with the soil particles, and this favors rapid growth of roots.

Good cultivation should be given the cuttings during spring and early summer. In extremely dry periods, irrigation along the rows may save many plants. A 60 to 70 per cent stand is considered a good average. With favorable conditions and after the leaves drop naturally in the fall, the vines should be ready to dig and store for spring planting. In some cases the plants are left in the nursery and transplanted in early spring.

NURSERY STOCK

Selection and Plants Per Acre.—First grade, one-year-old vines are usually the best to plant. Vines two years old or older may be used, but they will not come into bearing earlier or be more likely to give good yields. When the vines are set 10 by 10 feet, 434 plants will be needed for one acre; a planting distance of 10 by 9 feet requires 484 plants, and a spacing of 10 by 8 feet 544 per acre.

Time of Setting.—Grapes may be planted successfully in the Central and Eastern states either in the fall or spring. Spring planting is usually preferred especially toward the north, while in the sections in the south and west, fall plantings may be made. The danger from fall-set plants lies in subjecting the roots to winter heaving and killing. This may be prevented

if the soil about the vines is mulched with 3 or 4 inches of straw, straw manure or other mulches.

SITES AND SOILS

The most satisfactory sites are those that afford the maximum of warmth, sun, air and freedom from frost. In general, the vineyard should be somewhat above the level of the surrounding country. This is true because cold air settles to the lower levels where frosts are most likely to occur.

Reasonably level or moderately sloping land is in most cases more satisfactory. A fairly fertile soil and one upon which the fertility can be maintained with the least difficulty and expense is desirable. If the slope is mainly in one direction it may be possible to erect the trellis on lines across the slope and not necessarily on the contour.

Fig. 23.—Irrigating grapes in the Sacramento Valley. Water is metered to the crops at any rate desired. Waterlogging and drainage problems do not occur. Portable sprinkler irrigation gives an accurate control of moisture in the root zone. (Courtesy of Aluminum Company of America, Pittsburg, Pa.)

While grape lands should be fertile, they should not be excessively rich, because such soils are likely to produce a heavy growth of leaves and canes but little fruit. It is also true, that very light and poor soils, unless fertilized, produce vines of low vigor and a small yield of fruit. Heavy soils generally produce more fruit without added fertilizer than do the very light soils. Good soil drainage is essential. Consequently, all wet and seepy areas should be avoided. A moderately acid soil is generally best, but soils near neutrality are usually satisfactory.

Setting the Plants.—In planting, keep the roots of the vines covered with damp packing material, moist soil, damp gunny sacks, or in containers partly filled with water. Prune back all broken and straggly roots to a length of about 5 to 8 inches. In well prepared soil make the hole wide enough to prevent cramping the roots, and deep enough for the vine to stand about an inch deeper than it did in the nursery row. Place surface

soil over and about the roots in the bottom of the hole. When the hole is $\frac{1}{3}$ to $\frac{1}{2}$ full tamp the soil by tramping. Add more soil and when the hole is nearly full tramp again till the plant stands firmly in the soil. Let the last shovel full or two of soil lie loose on the surface to prevent soil baking. Do not put fertilizers in the holes, as they may do more harm than good.

PLANTING DISTANCES.—Spacing the rows 10 feet apart and the vines in the row 10 feet, generally proves satisfactory. Plantings are often made 8 by 10 feet and most of the commercial vineyards today may have this spacing. It is believed, however, that for Concord grown under favorable conditions 10×10 feet is likely to prove most satisfactory. Such distances permit the use of ordinary farm equipment between the rows and the use of a two-horse team. Weaker and slower growing varieties may be planted closer together than the stronger and more vigorous types. In the case of contour plantings, some variation in row spacing naturally occurs. Exact spacing of vines cannot be followed as in square plantings. There is also the possibility of placing the vines a little closer together in the row where the contour lines spread somewhat farther apart.

BUILDING THE TRELLIS

If possible the trellis should be established by the beginning of the second growing season. Where this cannot be accomplished, a stake at each vine may be used from time of planting until the trellis is erected. It is somewhat more difficult, however, to train the vines on stakes. The vertical two-wire trellis is suggested. The lower wire is placed about $2\frac{1}{2}$ feet above the ground and the top wire $2\frac{1}{2}$ feet above the lower wire. Number 10 or 11 smooth galvanized wire usually gives good results.

The posts of the trellis are usually set from 16 to 20 feet apart with two vines between the posts. In order that the posts may interfere as little as possible with the use of the "grape hoe" particularly, the posts are placed near the vines. Distance between the posts will depend on the planting space between vines in the row—whether 8, 9, or 10 feet. End posts may need bracing by the same method used in bracing line fences. Braces should give minimum interference with vineyard operations.

TILLAGE AND SOIL REPAIR

Tillage is essential as it affects both the quality and quantity of the fruit crop. The growth and vigor of the vine which is so necessary for good production is dependent largely upon it. Also, constant tillage from early spring until the seeding of the winter cover crop in mid-summer is a standard procedure in the best vineyards.

Such cultivation, however, tends to destroy the soil organic matter and induces surface soil erosion. Maintenance of the organic matter is of fundamental importance in vineyard soil management. To overcome these ill effects of tillage, a continuous process of soil repair and soil building is needed in every vineyard. This will be especially true on fairly steep slopes. A good growth of winter cover crops will help check and repair

damage. Coupled with this will be the constant attention to the stopping and repairing of small gullies on their first appearance, the use of manure and mulching material on eroded areas and careful attention to tillage practices.

Cultivate often enough during the spring and summer to keep the soil in good tilth and to control weeds. If an overwintering cover crop of rye, barley, or wheat is seeded about the middle of August it should be ready for disking or plowing under in early April. In vineyards which have not come into bearing, summer cover crops may be sown a few weeks earlier than winter cover crops.

Implements.—Tillage should be shallow to reduce soil erosion and avoid injury to the roots of the vines. A spring toothed harrow usually gives good results and the horse or grape hoe is considered one of the most valuable implements in the commercial vineyard. Proper use of this implement and its attachments saves much hard work in destroying weeds and grass under the vines.

COVER CROPS

A cover crop that will live through the winter or one that will freeze down may be used. Rye is perhaps the most commonly employed non-leguminous plant. It should be sown fairly early. Seeding at the rate of 1½ to 2 bushels to the acre is usually satisfactory.

Cowpeas are generally considered a satisfactory low-growing cover crop. Like other legumes, they add nitrogen to the soil as well as humus. Cowpeas (1½ to 2 bushels) may be sown broadcast or drilled between the rows in July. Other crops that may be employed as cover crops are mammoth clover, winter vetch, soybeans, and the like. A rotation of crops alternating between a legume and a good growing non-legume like rye has proved satisfactory.

Early in the spring, the cover crops should be plowed under, or if the cover is killed down by winter cold, it may be worked into the soil with a disk. Such crops as rye and winter vetch, should be sown with a drill. If sown broadcast, considerable hand hoeing may be necessary the following year to clean the plants out of the rows.

FERTILIZATION

The use of fertilizers in the vineyard, particularly for the Concord variety, is not as generally practiced as for many other fruit crops. This is likely to be particularly true on good soils. Where careful attention has been given to spraying, cultivation, pruning, the use of cover crops, and the employment of other standard operations, fertilizers may not be needed. If for any reason, vines remain unproductive and lack vigor even with good culture, fertilizers should be tried. They may be of particular value where such lack of growth and fruitfulness cannot be attributed to poor soil drainage, damage from frosts, or other factors. Furthermore, in sections where fertilization has been effective, and is a common practice, growers may profit by adopting a similar fertilization program. In vine-

yards ten or more years old, the use of fertilizers is more likely to be profitable.

Manure generally gives better results than a complete fertilizer or nitrogen alone. Through its application plant food is added to the soil and the organic matter supply is improved. When manure is not available, cover crops are depended upon to maintain the needed organic matter. Commercial fertilizers are generally considered as supplements to the organic matter supplied through the use of manure and cover crops.

The amount of fertilizer to use will depend upon the needs of the soil. Producers generally use from 200 to 300 pounds of a complete fertilizer, nitrate of soda or sulphate of ammonia to the acre, spread broadcast or applied in a drill in the spring just as growth is starting. Manure is applied in the late fall or winter at the rate of 8 to 10 tons or more per acre.

FRUITING HABIT OF THE GRAPE

The grape berries are borne on the current season's growth or shoots. These shoots develop from buds formed the previous summer in the axils of the leaves on that year's growing shoots which, after dropping their foliage in the fall, are termed canes. A shoot may produce from 1 to 5 fruit clusters, but with most of the ordinary sorts about 2 to 3 develop. Shoots from wood more than a year old are usually considered less productive. In fact, only one-year-old wood is selected for fruiting. Canes of medium size, about the diameter of a lead pencil or larger and 4 to 8 feet long, with medium length between the joints or nodes, are usually more productive than larger or smaller ones.

PRUNING AND TRAINING

The grape, unlike most other fruit plants, thrives best and produces most abundantly when subject to heavy cutting or pruning. Training has to do with form mainly, while pruning affects bearing primarily.

Time of Pruning.—The vines may be pruned any time after the leaves drop in the fall and before growth starts in the spring. In small plantings, where the work may be done in a short time, the pruning may be delayed until late winter or early spring. In larger vineyards, pruning should be started early enough for completion before growth starts. It should not, however, be done while the vines are frozen as they are very brittle then and easily broken.

Usually it is best to prune in late winter or early spring before growth starts. If the pruning is done earlier, the canes left for fruiting may be injured severely by cold weather. When cold injury occurs before pruning, the grower may still, by careful selection, find enough canes uninjured for a satisfactory crop.

Systems of Training

Single-Trunk Kniffin System.—A study of the methods best adapted to training and pruning American grapes shows that in general the single-

trunk four-arm Kniffin system gives the best satisfaction and most economical results. This is true, because, it can be learned more easily by producers, and handled with less difficulty than any of the other systems. Various investigators have shown that this method is particularly suitable for pruning and training the standard varieties of American grapes including the Concord.

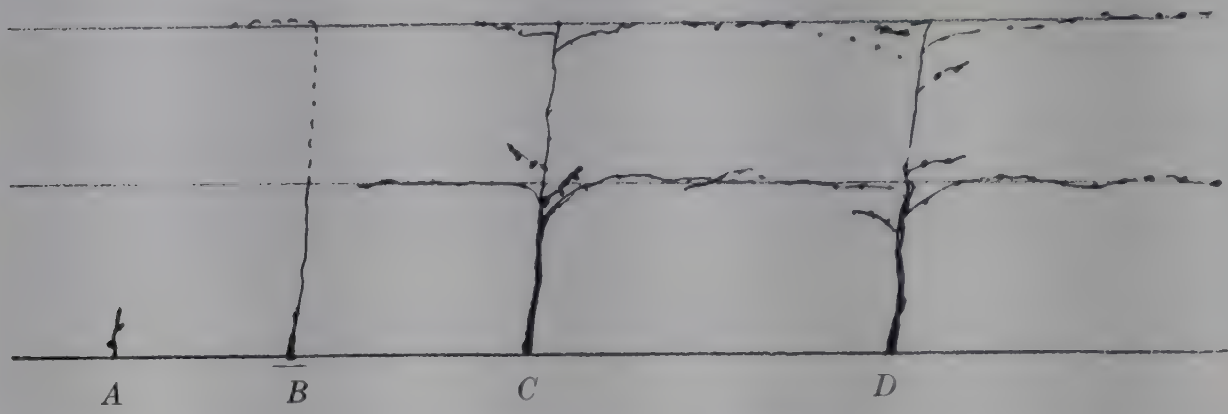

FIG. 24.—Showing the various steps to take in pruning and training grape vines from planting time until the framework is established and the full bearing period is reached in the fourth year or season after planting. One-year-old wood only is selected and tied to the wires for fruiting each year. *A*, a newly planted grape plant cut back to two buds. *B*, the same vine pruned the second year by cutting back a strong cane and tieing it to the lower wire. An unusually vigorous cane might be pruned as indicated by the dotted line of *B* and weak vines are again cut back as in *A*. *C*, pruning in the third spring by placing two canes along the lower wire and cutting them back to about four or five buds. Another strong cane is carried up to the top wire and tied. Side canes near top wire are trained to the left and right with four or five buds each. *D*, pruning in the fourth spring shows the vine with its permanent framework established. Note, the trunk with four canes of 10 to 12 buds each and four spurs of 2 buds each for fruiting wood renewal. This is the form and method to be used in pruning in the future.

PRUNING AT PLANTING TIME.—Fig. 24-A, the young vines are usually set out in early spring and the most centrally located and most vigorous cane is selected and cut back to 2 buds. All the other canes are removed. All dead and injured wood is cut away, and the roots shortened to about 5 to 8 inches. In the first season, the shoots that develop may be tied to a stake driven beside each vine or tied to the trellis so they may not be broken off in cultivation practices. In fact, a year may be saved in bringing the vineyard into bearing, by staking or tying young vines to the trellis during the first growing season.

PRUNING AFTER FIRST YEAR OF GROWTH.—Fig. 24-B, at the end of the first season, the growth may be sufficient for a selected cane to be tied at least to the lower wire of the trellis. From plants making a good growth a cane may be selected and brought up to the second wire, cut above a node and tied to both the top and lower wires. If for any reason, the growth is weak, the best cane is again selected and cut back to a spur of 2 or 3 buds and all the rest are removed close to the selected cane. One cane of the following season's growth, when large enough, is tied to the lower wire of the trellis and the upper wire if long enough.

PRUNING AFTER SECOND YEAR OF GROWTH.—Fig. 24-C, for the second pruning, if the main stem or trunk has not already been selected and tied to the top wire, the strongest, straightest, and most vigorous cane is chosen, carried to the top wire of the trellis, tied tightly to it, and then fastened rather loosely to the bottom wire. All other canes are removed. It is important that this cane be carefully selected as it is to become the permanent trunk of the vine. The straighter this cane is, the better, and it should not carry too many or too few buds. If the growth is long-jointed and very rank, an extra cane should be tied laterally to the lower wire in order to make use of some of the surplus nutrients. If this main cane, in order to reach the top wire, appears to include too many buds for the vigor of the plant, it is tied tightly to the lower wire. The cane is then cut off above the tie and continued to the top wire the next year.

PRUNING AFTER THIRD YEAR OF GROWTH. Fig. 24-D, pruning at the end of the third growing season is important since it determines the location of the permanent arms. It should mean the selection of two canes at or just below the lower wire. These should be shortened back to about 4 buds each and trained one to the left and one to the right of the trunk along the lower wire and tied near the ends. Two other canes should be selected just below or near the top wire, cut to about 5 or 6 buds each, and similarly trained and tied in each direction from the trunk.

This leaves about 20 buds, which are sufficient as the first commercial crop for a normal three-year-old vine. Two spurs of 2 buds each for both the upper and lower wires should be left as close to the main trunk as possible. These are selected from canes of the past season's growth and are to provide fruiting wood for the following year. Under good growing conditions, the vines may produce during the third year of growth from $\frac{1}{4}$ to $\frac{1}{3}$ of a full crop of fruit.

PRUNING AFTER FOURTH YEAR OF GROWTH.—This pruning is similar to that following the third growing season. From each average good growing vine, 4 canes of about 10 buds each consisting of the past season's growth are selected. Two of these should arise from wood near the upper wire and two others from wood near the lower one. Four spurs of 2 buds each from wood that grew during the past year are also saved. Two of these are selected from wood near the lower wire, and two from wood convenient to the top wire.

All superfluous wood is cut and pulled away. On the top wire one of the selected canes is strung along it, cut to about 10 buds, and tied to the wire near the base and end of the cane. Likewise, in the opposite direction, another selected cane is cut to about 10 buds, and tied to the top wire in a similar way. For the lower wire, the canes are handled in a like manner. It is important that the 2 spurs of 2 buds each be left fairly near both the top and lower wires and the main trunk in order to provide for plenty of fruiting wood the next year. A normal vine at this time should carry about 40 to 60 buds, or from 10 to 15 buds on each one of the four canes. More buds are left on vigorous canes, while fewer are allowed to remain on less vigorous growing ones.

The vines may now be considered fully mature and in full bearing. Pruning remains essentially the same as that after the fourth season's

growth. Occasional attention, however, needs to be given renewal of the arms, particularly when they become so long that the fruiting wood on the trellis overlaps or crowds. Vigorous vines are sometimes trained in a similar manner upon a three-wire trellis, leaving about 60 to 70 buds for fruiting instead of 40 or 50.

Pruning Should be Based upon Vigor

The pruner should understand that for an average vigorous Concord vine, for example, about 40 to 50 buds on four canes of the past season's growth should be put up on the two-wire trellis for best fruit production. Average good vigor is usually interpreted to mean the growth of many canes in one season ranging in length from about 10 to 15 feet.

On the other hand, distinctly less than average vigor may mean the growth of canes averaging from about 1½ to 2½ or 3 feet in length. Naturally there may be considerable difference in growth and vigor of the vines in different parts of the vineyard and even from vine to vine. But, for the vine making the weak growth referred to above, perhaps, the pruner should leave not more than 20 to 30 buds for fruiting on the four canes to be put up on the two-wire trellis.

Furthermore, the pruner should understand thoroughly that the heavy pruning (cutting to 40 to 50 buds) of the vigorous and unusually vigorous vines may cause excessive vegetative growth or growth of a water sprout nature. Also, such growth is unfruitful or unproductive, and conducive to uneven berry ripening. Therefore, for such vines it is advisable to put up more fruiting wood. Instead of leaving 40 to 50 buds, it may be well to leave for fruiting from 70 to 90 buds, about equally distributed on the four or more canes. In some vineyards of more than average vigor it may be well to consider the matter of constructing a three-wire trellis instead of a two-wire trellis. If such vines are pruned according to their vigor, fruit production may frequently be doubled or at least markedly increased.

In contrast, if the weak or non-vigorous vines are allowed to fruit through the putting up of 40 to 50 or more buds as we should for the fairly vigorous vines, their weakness or reduced vigor is generally accentuated or made worse. Such vines generally fail to mature their fruit properly. They are sure to produce a small amount of fruiting wood and continue to be unprofitable under such pruning treatment.

The problem can be corrected or improved considerably by reducing materially, for such weak vines, the amount of wood left for fruiting. As stated above, for vines making only 1½ to 2 feet of growth for each cane produced in one season, perhaps not more than 4 to 5 buds each should be left on each of the four fruiting canes.

With such poor vigor or growth it would certainly be advisable to supplement the pruning practice by applying manure, if possible to the vineyard at the rate of 8 to 10 loads or tons per acre. Where manure cannot be obtained, nitrogen fertilizers at the rate of 250 to 350 pounds per acre may give good results in stimulating increased growth and fruitfulness. Some soils may respond better to the application of a complete fertilizer like 4-12-4, 6-18-6, 8-24-8 or some other combination fertilizer. An actual

application may be required to determine the needs of the soil. Furthermore, a soil analysis may aid in determining the fertility needs of the vineyard soil.

TYING

In most commercial vineyards, grape twine, a product purchased from dealers in horticultural products is generally used. Rag strings are also employed. Cloth materials of several different grades and kinds are often purchased for use. These are torn and cut into strips suitable for tying to the wires both trunks and canes of young and old grape plants. If only moderately strong strings are used, less difficulty may be experienced in the removal of the old fruiting canes at the time of pruning.

BLACK ROT OF THE FRUIT

Black rot is the most common and generally the most destructive fungous disease of the grape; in fact, it usually does more damage than all other diseases and insects combined. It is most prevalent during wet seasons and may cause a loss of 50 to 100 per cent of the crop. Besides the damage done the fruit, the leaves and shoots are subject to attack. The green, growing parts of the vine may also be damaged. On the leaves the fungus causes reddish-brown circular spots with darker margins. Scattered over them may be found small dark brown pimples or pustules. When numerous, the spots run together in large irregular areas.

The infected berries at first show small whitish spots, but, as the diseased portions increase in size, they become brown in color and sunken with numerous black pimples or pustules on the surface. In the final stages the berries become shriveled, black mummies. Black rot may be controlled by thorough and timely sprays.

SPRAYING GRAPES

General Suggestions.—Commercial vineyards will require a gasoline power sprayer. It should be capable of producing a spray pressure of 450 to 500 pounds. For good coverage in the control of black rot, other diseases and insect pests, from 200 to 250 or more gallons of spray per acre may be required.

Methods of Application.—The two methods now employed in applying the sprays are the trailer and fixed boom or hood types. Most of the growers are still using rods and nozzles that trail the sprayer and the spray is applied on one side of a row at a time. This method has some advantages in that it may be quickly and effectively changed and adjusted to the requirements of coverage for both fruit and foliage. It is particularly effective for the spraying of dense and heavy foliage.

The so-called fixed boom when properly prepared and operated usually gives more uniform and satisfactory results than the trailer method. It is rapid, efficient and economical of spray materials. Both sides of one row are covered at the same time. The booms may be attached to the side of

the power sprayers. Six or more nozzles are adjusted in such a manner as to give a fine fog-like spray from below the vines and fruit clusters, from both sides and from above, thus covering thoroughly the fruit and foliage as the boom passes over the row.

Downy Mildew Control

Station workers have generally found that Ferbam has proven to be less effective in the control of downy mildew than Bordeaux. This has been particularly true for susceptible varieties like Herbert and Catawba. During the past few years, with unusually wet summers in some sections there has been considerable complaint among producers of attacks even on Concord, a very resistant variety. In some instances, mildew attacks have occurred after the black rot sprays were applied.

Some growers report good control of mildew by using Ferbam in all or most of the prebloom sprays followed by Bordeaux in the later sprays. Also, investigations with various combinations of Ferbam and Bordeaux have shown no more injury to fruit and foliage than has occurred with Bordeaux alone. Such a schedule of spraying is worth considering although all the possibilities of foliage and fruit spray injury have not yet been fully explored.

Comments on Grape Spraying Programs

Local or seasonal conditions may require some modifications of the schedule nearly every year. Where there is any great risk of black rot the interval between the early sprays should not exceed 12 to 14 days, and with very rainy weather, especially during the critical period from just before bloom to the setting of the fruit, sprays might well be applied within 10 days of one another.

Apply Sprays When Most Timely.—It is to avoid such long intervals between sprayings that modifications in the basic schedule are advisable. If rainy weather prevails the third cover spray may prove valuable, applied about 10 to 12 days after the second cover spray. Use Bordeaux 6-8-100 or Fermate 1½ lbs. to 100 gallons.

Good Coverage is Essential.—Unless approximately 200 to 250 gallons or more of spray is used per acre, the thoroughness of the application may be questioned. The spray should be broken up into a fine fog-like mist. One or a cluster of two or three medium capacity disc nozzles on a 3- or 4-foot rod will permit better handling and give a better type of spray than the modern fruit tree equipment. Both the under and upper sides of the leaves should be covered.

The best coverage of the fruit is obtained by directing a fine mist to the clusters without getting the nozzles too close to them. Just an instant is long enough to place numerous droplets on the berries. If too much material is applied, or the force of the spray is too great, the droplets will enlarge and run off. However, spraying all parts until the run-off starts is usually much more effective in disease and insect control than under or skimpy

spraying. Spraying should be done on each side of each row rather than by applying it from every other middle row by trailer method.

SPRAYING SUMMARY.—In large or small vineyards, begin spraying in spring when the shoots are about 2 or 3 inches long. Use Ferbam $1\frac{1}{2}$ lbs. to 100 gallons. Or use Bordeaux 6-8-100 plus lead arsenate $2\frac{1}{2}$ lbs. to 100 gallons. Apply regularly at intervals of about 12 to 14 days. Five applications may be needed. Include lead arsenate as indicated above.

Similar to the spraying of other fruits, changes in the use of spray chemicals and spraying practices are occurring practically every year. A brief review of some of the changes with timely information for the year 1952 follows:

During the past two years in some areas dormant applications of 3 or 4 per cent oils have not given satisfactory control of grape scale. Good control, it is claimed, can be obtained through the application of two properly timed sprays at ten-day intervals using 1 lb. of 25% or $1\frac{1}{2}$ lbs. of 15% parathion wettable powder. Apply the first spray about two weeks following the appearance of the first young scales on the trunks of the grape plants. The second spray should follow in 10 days. The "crawlers" or young scales may be found in many sections from about June 5 to 15. Parathion may be safely mixed with Ferbam but it is not compatable with Bordeaux. In using Parathion, growers should follow all the precautions printed on the labels.

Ferbam is not generally effective against downy mildew and cannot be depended upon for good control where conditions are favorable for mildew development. Since downy grape mildew causes injury to fruit and foliage later than black rot, some growers use Ferbam in the first two or three grape sprays when there is the greatest likelihood of injury by Bordeaux. Then, they change to Bordeaux for the rest of the sprays needed during the season.

Recently, DDT has been found to be very effective against the grape berry moth, leaf hopper and flea beetle. Flea beetles however, only occasionally attack grapes as growth starts in early spring. Inspect for injury before buds open. Sprays are needed only when the insect is found doing injury in damaging numbers.

Downy mildew first appears as light-yellow spots on the upper surfaces of the younger leaves. Later whitish moldy colored growth develops on the lower leaf surfaces. When mildew is found, with only a few spots on the foliage or vines, a change from Ferbam to Bordeaux or other effective sprays against the disease should be made at once.

MUSCADINE GRAPES

The growing of Muscadine grapes (*Vitis rotundifolia*) has been a rather common practice particularly in the southeastern states since early times. The fruit is used for various purposes such as wine, jellies, jams, preserves, canned grapes, and even pie making. On account of the species susceptibility to injury by winter cold, growing areas are limited to districts where the temperature does not drop much below 10° F. With the lessening of restrictions for wine making about 19 years ago, the planting of Musca-

dine vineyards in favorable growing sections has been stimulated to a moderate extent.

Varieties

Scuppernong, one of the oldest and most important varieties, is a good grower and the fruit ripens in late August. It is rated as productive and is generally considered well adapted for home uses and wine making. *Misch* is also well suited to wine making. It ripens late and is generally considered adapted for both home and commercial uses. *James* is a black fruiting variety that ripens late. The vines are slightly trailing but vigorous. Like the varieties mentioned above this one fills the needs for dessert, culinary uses, wine, and market demands. *Thomas*, an early midseason variety, may frequently ripen its fruit unevenly and the fruits may have a tendency to shatter or drop from the clusters. However, it is considered the best variety for unfermented juice and preserve making. *Flowers* has black fruits rated as good for wine making. Although the skins of the fruits are tough yet they become tender on cooking and are used for ketchup, spiced grapes, and conserves. Still another variety that has met with favor is *Eden*. It ripens early and uniformly and each season a first and second crop is produced. This variety is also well suited for the various home uses and for wine making in the home or for commercial purposes.

Pollination

Such varieties as Thomas, Flowers, Memory, Eden, James, Scuppernong, Hopkins, and Misch are self-unfruitful, due to the production of sterile pollen from the flowers at blooming time. Furthermore, all of the wild Muscadine grapes producing both pistillate and stamiate flowers are pollen-sterile.

The vines producing fertile pollen are often called "mules" although the flowers may contain rudimentary pistils. These "mule" vines that produce fertile pollen are used for pollination purposes. However, they should bloom at the same period as the varieties to be pollinated. In commercial and home plantings, it is suggested that every third vine in every third row be planted to a staminate or male variety. Honeybees should be placed in the vineyard or kept near enough for working the blossoms at blooming time.

Considerable work has been done toward the development of self-fertile Muscadine varieties of grapes. It is important, therefore, that growers keep in touch with their respective experiment stations in order that they may take advantage of the latest findings. Until sure that the varieties that are being planted are self-fertile and do not require the growing of staminate sorts, provisions for adequate pollination as suggested should be made.

Training and Pruning

Two methods are employed. One is known as the horizontal or overhead system and the other one is termed the upright or vertical method. The vertical trellis system which is much like the four-cane Kniffin system is the most economical in constructing and the vines are more convenient

for such vineyard operations as pruning, spraying, harvesting, and intercropping. Through the use of six arms instead of four, the Kniffin system may be adopted.

Spacing Distances.—Moderately vigorous varieties may be set 15 feet apart in rows 10 feet apart. Strong growing varieties like Scuppernong on the vertical trellis are often set 10 feet apart each way. Where this method is used, the plants are usually thinned as they grow larger to a distance of 20 feet apart between the rows.

Propagation.—Some form of tip-layering is usually employed in reproducing Muscadine grapes. The parent stem is bent or arched into the soil and made secure by covering with earth. After rooting occurs, the stem of the young plant is cut a few inches from the roots, in the late fall or early winter. The plant may then be lifted from the soil and planted in the nursery or in the vineyard. In general the Muscadine grapes thrive under the same cultivation, fertilizer practices, and other care that is given the American grapes.

EUROPEAN GRAPES
(*Vitis vinifera*)

Semiarid and subtropical regions are best adapted to the growing of the so-called Old World or European grape. On a world basis about 90 per cent of the cultivated grapes consist of this European type, *Vitis vinifera*. Extensive commercial plantings are found in the sub-tropical and more or less arid sections of California, Arizona and the lower Rio Grande River Valley of Texas.

Cool, rainy winters with hot, dry summers seems to meet the growing needs best. Irrigation may supplement in most sections to advantage the annual rainfall. However, an average annual rainfall of about 20 to 25 inches if properly distributed throughout the year may be adequate for crop production. A chief need of vinifera grape varieties is much bright sunshine and dry summers. Also, enough winter cold is required to keep the vines dormant for several weeks.

Propagation and Culture.—The propagation methods are quite similar to the practices used successfully in reproducing American grapes. The reader is, therefore, requested to study the suggestions given in this chapter for the propagation of the kinds grown in most parts of the United States. However, soils infested by Philloxera insects or nematodes should not be used for rooting cuttings of vinifera grapes. Cuttings of resistant stocks are employed and the varieties desired are grafted on these at suitable periods of growth and seasons.

Spacing of Vines.—In warm climates where fertile soils prevail about 100 square feet or more may be needed for each vine. On the other hand, in cooler climates and on less fertile soils about 80 square feet may be adequate. This will be especially true for moderately thrifty or vigorous vines. Trellised varieties are often planted about 8 × 12 or 10 × 10 feet. Avenues 18 to 20 feet wide at intervals of 300 to 600 feet or equal to the length of the irrigation furrows may be established. Ample space for the operation of machinery should be left at the ends of the rows where it is

necessary to turn. Such space may be required for harvesting and pruning operations.

Pruning Vinifera Grapes

Pruning consists of the removal of canes, shoots, leaves and other vegetative part. The purpose is to give the vine a definite form and keep it in limits for practical cultural and handling operations such as pest control, harvesting operations, tillage and irrigation.

Also, cutting the vine tends to reduce growth and fruit bearing and to concentrate the vigor of the vine in the parts remaining. The systems of pruning are head pruning, cane pruning and cordon pruning.

Fig. 25.—A mature horizontal, bilateral, cordon-pruned vine, "European" grape, *Vitis vinifera*. (Univ. of Cal. Agr. Exp. Sta.)

Head Pruning.—The vine is developed into a small, upright stub and the system consists of head training and spur pruning. It lends itself well to varieties that fruit well on short spurs. The raisin Muscat, such table grapes as Tokay and most wine grapes may be pruned to the system.

Cane Pruning.—In this system the vine is given a trunk similar to the method in head pruning. Only two arms on each side of the head are required. This system serves the Thompson Seedless and full crops may be had for cane pruning of varieties that produce small clusters.

Vine Supports.—Some sort of support should be provided for all vines. Stakes about 4 to 6 feet long are satisfactory for vase formed vines. When the vines are self-supporting in 6 to 10 years, the supports may be removed.

A 6 foot stake at each vine is sufficient for the simple two-wire trellises. Two No. 11 or No. 12 smooth galvanized fencing wires at 34 and 46 inches from the ground, are stretched along the rows. The building of the trellis should not be delayed longer than the winter following transplanting.

For strong-growing varieties a spreading top trellis may be constructed. A crossarm is fastened to the top of each alternate stake and braced at the lower end to hold the crossarm at an angle of about 30° from the horizontal.

FIG. 26.—A mature head-pruned grape vine, "European" grape, derived from wild species, *Vitis vinifera*. (Univ. of Cal. Agr. Exp. Sta.)

The upper end of the crossarm is about 21 inches long and the lower end about 15 inches in length. On the crossarms three wires are placed and on the stake directly beneath, one wire is attached. The advantages are more fruiting wood, better light exposure, and thinning, girdling and harvesting operations are facilitated.

CORDON PRUNING.—In this system a definite head is not produced. The elongated trunk bears arms about 8 to 12 inches apart over the most of its

length. The cordon system is limited particularly in California to the table grape varieties. Some of these are Emperor, Malaga, Red Malaga and Ribier.

Thinning Vinifera Grapes

Flower cluster thinning, cluster thinning and berry thinning are practiced. Each practice reduces the number of flower or fruits. As a result better growth and development is possible for the flowers and fruits that remain. Varieties like Muscat of Alexandria and Dattier that develop loose clusters may be benefitted by flower-cluster thinning. Cluster thinning which requires the removal of the entire clusters is used most extensively soon after the berries are set. Berry thinning is limited to varieties that set compact and large clusters. The thinning is done soon after the berries are set by cutting off a portion of the main stems. The object is to reduce berry production to the amount desired.

Girdling Vinifera Grapes

Girdling consists of the removal of about $\frac{3}{16}$ inch strip of bark from around the main trunk at blooming time. The practice increases the set of seedless berries. The yield of the Black Corinth with girdling is increased from small clusters of seedless straggly berries to marketable sized clusters of high quality. For increasing berry size girdling is also practiced on Thompson Seedless vines soon after the berries have formed.

Irrigation

In the Vinifera grape growing districts irrigation has been practiced for considerable periods where sufficient water is available. Furthermore, with the introduction fairly recently of various types of portable irrigation equipment rapid developments are occurring. It is now possible to apply water profitably and economically on sloping and irregular land surfaces.

Varieties of Vinifera Grapes

A few of the important varieties for special purposes will be listed and they apply particularly to California. The Mission grape was once considered the ideal for culture. A leading variety for wine making is Zinfandel; for shipping, Flame Tokay and many others of less importance; for raisins, Muscat of Alexandria. Other sorts grown extensively for red wine are Petite Syrah, Buschet, Mataro, Carignarre, and Blue Ebling. For dry wine and still other wines many more varieties are used. The chief raisin grape is Thompson Seedless or Sultania which may give rise to as much as 80 per cent of the raisin production in California. Other popular raisin varieties are Muscat of Alexandria and Black Corinth. Leading table grapes consist of Thompson Seedless, Flame Tokay, White Malaga, Emperor, Red Malaga, Ribier, Cornichon, Almeria, Rish Baba, and Olivette Blanche.

Chapter 11

Growing Cane and Bush Fruits

BLACKBERRY, RASPBERRY AND DEWBERRY

THE cane fruits or brambles have biennial tops and include the blackberry, red, black and purple raspberry, dewberry, and related forms and hybrids. The brambles are grown widely throughout the United States and Canada. In the less favored areas, the plantings may consist of a few canes for home uses, while commercially under good growing conditions, their culture may consist of extensive acreages. These fruits differ from most others in having the distinction of being native as a rule.

Profitable production returns may be expected in 2 or 3 years after planting. Furthermore, production from small acreages requiring the attention of only one man, except at harvest time, may constitute a profitable enterprise even upon high-priced land favorably located for the rapid and easy disposal of the fruit.

It should be noted that the bramble fruits are soft and highly perishable. The berries, therefore, must be handled carefully and quickly. Cold storage facilities will, of course, aid materially in making their growing a success. In general, the fruit ripens rapidly and in a comparatively short period, which usually requires the employment of sizeable picking crews.

The satisfactory cropping life of a bramble planting may range from 4 to 5 years to as much as 7 to 9 years. Good harvests will depend much upon favorable factors and the care and attention given the plantings. The income, however, when compared with that received from field crops, tree fruits and garden crops may be entirely satisfactory.

FRUITING HABIT.—All the brambles produce fruit on the canes or stems of the last season's growth. Canes of the previous summer produce the crop of fruit for the following year. After fruiting or harvest the canes die and are replaced by new shoots arising from the plant roots and crowns. The first year after planting is devoted to new shoot growth and no fruit is borne. In the second year after planting, the limited stem growth of the previous year may produce a small amount of fruit and then die. For the third year, there may be enough canes produced in the second year for a noticeable crop of fruit, after which the old fruiting canes die. The amount of fruit produced during the third year after planting will depend upon the vigor of the plants, varieties and the character of the fruiting canes. Anywhere from about one-third to two-thirds of a full crop may be harvested. In the fourth and following years after planting, the canes

should be in full production. Those that winter-over bear the current season's crop and then die, and new shoots produce canes to replace those that die, and to fruit the following year.

SOILS AND SITES.—All brambles may thrive upon a wide range of soil types. Soils of moderate fertility and well supplied with humus are desirable. A strong loam or clay loam, retentive of moisture and well drained is usually best. Frequently soils too rich in organic matter may produce vigorous and unproductive canes. On the other hand, soils poorly supplied with moisture may fail to grow normal sized berries. Distinctly gravelly and sandy soils may develop too much heat for good bramble production. On wet and flat lands, the canes may show increased damage from both heat and cold. Producers generally find that northern exposures or northern slopes on account of being cooler in spring and summer and possessing deeper and more fertile soils, usually give the most satisfactory results.

Brambles usually bloom late enough for the fruit flowers to escape injury from late spring freezes and frosts. The canes are, however, subject to injury by winter cold. It is important, therefore, that the planting site be high enough for the cold air to drain away to lower lands. As stated above, good soil drainage is essential and all wet spots or areas should be avoided because the canes on such soils are much more likely to continue late fall and early winter growth and thus be made susceptible to winter cold injury.

SOIL PREPARATION.—If an intensively cultivated crop has been grown the year previous on the planting plot, all the better. Fall plowing for early spring planting is generally preferred. Also, deep plowing and thorough pulverizing of the soil is suggested. Where possible, a leguminous cover crop like cowpeas or soybeans should have been plowed under. A liberal application of manure at the rate of 8 to 10 tons per acre should prove very helpful in crop production. Cover crops or manure generally give better results in fitting the soil for growth of plants and fruit production than the use of commercial fertilizers. However, both methods of soil building may be combined to advantage.

PLANTING TIME AND SPACING.—Spring planting is generally practiced, but toward the south fall setting may give good results. Plants are set about as deep as they stood in the nursery, and it is important that the soil be firmed about the base of the plants. In the planting process the roots of the nursery stock should be kept in a pail of water or wrapped in damp packing material to prevent drying out and shriveling.

In setting the plants, the spacing distance between plants is usually 6 to 8 feet between the rows and 3 to 4 feet in the rows. Too much crowding of plants usually results, when the plants are set in rows closer than 6 feet apart. In fact, many successful growers maintain that the distance between rows should not be less than 8 feet. The wider spacing gives more room for cultural operations such as cultivation, pruning, spraying, harvesting and the like. Stronger and more fruitful plants may be produced on some soils through wider spacing. On the other hand, where brambles are grown in hedge rows, they may be spaced as closely as 3 feet apart. A solid or thick row may be formed more quickly through close planting.

Cultivating and Mulching.—Timely and thorough cultivation from early spring until mid-summer at intervals of 10 days or 2 weeks may be needed to keep down grass, weeds, and plants arising from the roots of the blackberries and red raspberries. Deep clutivation is avoided to prevent the destruction of surface growing roots. Attention is given to keep the plants thinned to spacings of from 1 to 3 feet apart; weeds are destroyed and the soil pulverized.

Mulching the soil sufficiently to prevent weed growth in and between the rows using straw, old hay free from seeds and other litter may give good results. The brambles and bush fruits respond well to mulching. Soil erosion problems are solved with the mulch and the cost of cultivation is eliminated. The chief concern of the grower may be the obtaining of mulch materials at reasonable prices. In many instances, it may be necessary for producers to grow and handle their mulching materials such as straw, hay, etc., in order to have it when needed, in the quantities desired and at conservative costs.

Fertilization.—Where proper cultivation or mulching, pruning and other practices fail to bring good production, soil fertilization may be needed. In general, manure gives the best results and strawy manure may be used as a mulch. If manure is not available, trial applications of both commercial nitrogen and complete fertilizers may be tested on comparatively small plots. This suggestion applies to both cultivated and mulched plantings. The commercial fertilizers may be applied at the rate of about 250 to 300 pounds to the acre equally well when the plants are grown under either mulch or cultivation.

Irrigation.—Where rainfall is not adequate, irrigation may generally be depended upon to bring markedly increased yields of high quality fruit. Moreover, the cane and bush fruits may be crops that the grower can well afford to irrigate even at considerable cost. This is true because the increased yields and prices received may more than justify the extra irrigation expense.

THE AMERICAN BLACKBERRY

(*Rubus argutus*, *Rubus allegheniensis* and other species)

In every state in the Union, the blackberry may be found growing for home uses or for commercial production, one or both. Some of the leading states with production based upon the crop harvested from the wild as well as from cultivated plantings are Texas, Missouri, Oklahoma, Arkansas, New Jersey, Illinois and California. About nineteen states are reported as really important in blackberry production.

Propagation.—Plants for setting new patches and fields are produced from suckers arising from the roots and crowns of old plants. The blackberry may also be reproduced from root cuttings. One-year-old sucker plants or plants of the same age produced from cuttings are usually planted. The cuttings are made in late fall, early winter or early in the spring from roots about the size of a pencil or a little larger. Roots are cut into sections or pieces about 4 or 5 inches long and planted in nursery rows $2\frac{1}{2}$ to 3 feet wide and in the row about 10 to 12 inches apart. The cuttings are covered

with soil to a depth of about 2 to $2\frac{1}{2}$ inches. The sprouts arising from the cuttings should be given timely and thorough cultivation throughout the spring and summer. During dry periods supplementary irrigation should prove helpful in producing strong growthy plants.

PRUNING AND TRAINING BLACKBERRIES.—The erect or upright growing blackberry, depending upon the variety, may be pruned, thinned and trained without the support of a trellis or stakes. Sorts that trail or lie on the ground, usually give improved yields if trained on a wire trellis. A one- and two-wire trellis may be used. Strong and upright growing varieties are often tied to stakes or cut back sufficiently to enable them to support their own weight. Good growing varieties may be thinned to stand about 12 inches apart.

The actual cutting before growth starts may consist of shortening back rangy canes, thinning to about 12 to 18 inches apart, and the removal of all dead and weak canes and laterals. Vigorous growing varieties may be cut back as much as 2 to 3 feet or more. The pruning work is usually performed in early spring before growth starts. However, it is usually advisable to remove and burn all the old fruiting canes as soon after harvest as possible. Cutting and burning the canes following harvest may rid the patch or field of dangerous diseases and harmful insect pests. Additional light and plant food is made available for the young shoots that will replace the old canes. Both berry size and quality may be improved through judicious and careful pruning and thinning.

With most varieties of the blackberry, from 2 to 3 inches of the tops of new shoots are pinched off when the plants are from 20 to 40 inches high. Very vigorous sorts may be pinched at somewhat greater heights. For the pinching work to be of the most value to the crop the following year, it should be done 2 to 3 times at intervals of about 10 to 14 days, during the late spring and early summer.

VARIETIES OF BLACKBERRIES.—The varieties of blackberries are often divided into two groups, early and late producing sorts. On account of the competition with wild varieties, the early fruiting cultivated kinds are generally preferred. Early varieties may also mature their fruits before hot dry weather prevails in some sections. The Early Harvest is still the favorite in many districts especially as an early commercial variety. Alfred, a new variety, begins fruiting about a week earlier than Eldorado and continues for 2 weeks. It seems promising for the home fruit planting. Eldorado, Blowers, Ward, and Snyder are given a high rating in the Central States area. On the Pacific coast the Lawton variety is grown extensively. Such hardy types as Agawam, Ancient Briton, Eldorado, Taylor, Mersereau and Ebony King, a new variety, are desired by producers in some districts especially where hardiness is needed.

The Raspberry

The raspberry may be divided into three classes. These are Red Raspberry (*Rubus strigosus* and others) and the Black Raspberry (*Rubus occidentalis*). All of the states of the Union grow raspberries and the fruit is found in home and commercial plantings in Canada and Alaska. The

greatest production is centered in the East and West. For the East, the North Atlantic and the Middle Atlantic States are first in production. Over the entire country New York is considered most important in production. Other high producing states are Ohio and Pennsylvania; more recently the Pacific Coast States have made substantial gains in production and particularly in processing the fruit for distant shipments.

Varieties to Plant.—For all fruit and particularly the cane and bush fruits, growers should be guided mainly by the suggestions and recommendations of their respective Agricultural Experiment Stations. This is true because local experiment station workers have first-hand information as to the varieties, local conditions including sites, soils, water needs, likelihood of injury from cold, drought, insects and diseases.

Fig. 27.—Red raspberries bent down and partially covered by a plow to prevent winter cold damage. (A) bend down as flat as possible without breaking canes on right side of plow; (B) one or two furrows about 6 inches deep are plowed on both sides; (C) finish covering with shovels to depth of 4 to 6 inches. (Ore. State Agr. Exp. Sta.)

Red raspberry varieties that might be considered profitably are Cuthbert, Latham, Lloyd George, Ranere, Surprise, Washington, Newburgh and Indian Summer. Still other sorts that are listed as promising in some sections are Marion, (purple), Sunrise, Early Red, September (fall bearing), Taylor (red), New Logan (black) and Morrison.

Some Black and Purple Raspberry varieties that are still popular among producers are Cumberland, Gregg, Munger, Potomac and Logan. The purple raspberries are hybrids between the red and the black. Sodus is a purple raspberry of large size originated by the New York Station. It is considered one of the best of its kind. Another purple sort of value is Royal.

Propagation of Raspberries

RED RASPBERRIES.—The suckers or shoots that grow from underground stems of plants are dug in the fall or early spring. In and between the rows, these shoots or suckers may push through the soil in abundance. Where large numbers of plants are wanted the entire row may be plowed out. The largest and most vigorous young plants may be used or sold, and the less thrifty and smaller ones may be set in a nursery row to be used as transplants.

FIG. 28.—A row of raspberries properly covered for winter protection. (Ore. Agr. Exp. Sta.)

BLACK AND PURPLE RASPBERRIES.—These are usually propagated by means of tip layers. When the ends or tips of the canes develop small curled leaves in late August or early September, this may be a favorable time for tip-layering. The tips are pressed against the soil and covered lightly leaving 2 to 3 inches of the ends exposed. Firming the soil moderately holds the tips in place and prevents them from blowing out. As the tips are tender and easily injured they should be handled carefully. They may grow a good root system by late fall or early winter.

At this time or early the next spring, the rooted tips are cut away from the parent cane leaving a few inches attached to serve as a handle. They are then dug with spade or hoe. The rooted layers may be planted in the permanent location or held over in a nursery row for later use. In the permanent planting, that part of the cane used in handling is removed close to the newly formed roots to avoid diseases. In propagating large numbers of tips, a shallow furrow is plowed near the base of the plants. All of the lateral tips suitable for use from both sides of the row are placed in the furrow in a horizontal position and the ends of the canes excepting the tips are covered with soil. The following year the rooted tip layers are cut from the parent plants and may be dug with a plow. However, somewhat better results are usually obtained by hand digging and setting but the methods are more expensive.

THE DEWBERRY

Sometimes the dewberry, a trailing blackberry, is trained to posts set in the rows. More often a trellis is used. However, large and small producers may allow the canes to trail on the ground. The plants are often set about 4 to 5 feet apart between the rows. Cultivation may be practiced in one direction only. The new shoots are pushed and pulled into the rows. Some of these may root at the tips, and produce new plants which are left or dug for transplanting elsewhere. Early in the spring the old dead fruiting canes of the previous year that were not cut and burned soon after harvest are removed. Some thinning of the plants may be needed but usually only dead and injured canes are removed with a minimum amount of damage to the new fruiting canes.

Mulching in the fall with straw, leaves, or other litter may help materially to reduce winter cold injury to the canes of some varieties. If a portion of the mulch is left on the soil, it may conserve moisture when needed badly in late spring and early summer. The producer may also be able to harvest cleaner berries for home or commercial uses.

The dewberry patch in the south central districts may be handled in the above manner and with but few changes for 4 or 5 years or more. After such a period and in the renovation process, the canes may be cut level with the soil, raked and pulled away with the mulch for burning. The soil in and between the rows may then be disked and cultivated thoroughly after which some thinning of plant clumps may be needed so that they will stand from 2 to $2\frac{1}{2}$ feet apart. Where winter injury or soil erosion has thinned or reduced the stand considerably some resetting of plants from thick to thin areas may prove helpful.

With such renovation, no crop will be harvested the current year but the following year and later ones should bring good returns. During the season following renovation, the soil may be kept cultivated or mulched. So far as yields are concerned there should not be much difference between cultivation and mulching.

Some commercial dewberry growers have for more than 20 years, burned over their patches and fields at intervals of about 5 to 7 years. The burning

is done during the winter season and constitutes about the only renewal operation that is employed. Even without cultivation in the spring after burning, it is claimed that good results are secured. Where there is considerable concentrations of litter such as grass, leaves, weeds, dead canes and the like, burning may develop enough heat to kill the crowns of the dewberry plants. The burning practice, therefore, is not generally recommended and if used, caution and good judgment should be employed.

The variety of dewberry of ranking importance today is the old well-known Lucretia. The season is early, the plants are medium in vigor, the canes usually need support, and the plants are hardy and fairly productive. The Bartel has proven hardy in the North and the southern type is represented by Manatee and the Skagit Chief. Still other varieties are grown in the West. The main production in commercial centers is from Lucretia and Bartel. McDonald is grown in both the East and West, the Mayes in Texas and Premo in North Carolina.

TRAILING BLACKBERRIES

The different varieties of trailing blackberries may be distinguished by the reddish color of the berries when they are mature. However, they are all properly grouped with the true blackberry. In fact, the Logan, Phenomenal, Boysen, and other similar sorts, are really varieties of (*Rubus ursinus* var. *Loganobaccus*). Also, the youngberry is now classified as a hybrid derivative of this same group.

Winter Temperatures.—When temperatures drop to zero or below, severe injury may be done to the canes and crowns of this group of trailing blackberries. Production, therefore, is largely confined to mild climates of the Pacific Coast states, and the southern section, and the South Atlantic states. They can be grown successfully, however, in more severe climates but good winter protection is essential. This may consist of mulching, as winter approaches, according to the needs by laying the canes down in plowed furrows and covering them with varying depths of soil depending on the need. In the spring, the coverings should be removed. The canes are then lifted and thinned to about 10 to 12 inches apart. Rangy ones that extend out into the rows should be shortened back, and those that are weak or injured by winter cold should be removed. Furthermore, if the old fruiting canes of the past season were not removed soon after harvest, it is important that they be cut in the spring and pulled out and burned.

Trellesing Trailing Varieties.—All the members of this group require trellesing for good production. This work should follow lifting the canes and pruning. Some growers use a trellis similar to that employed for grapes and various types and kinds may be found that meet special needs and requirements. Again it must be remembered by the producer toward the North that the canes must be removed from the trellis in late fall or early winter, laid down on the ground and covered properly with mulching material or buried in the soil of plowed furrows. This is for protection against winter cold. The culture may represent a great deal of painstaking and to some disagreeable work. Since the vines may fruit

heavily and the quality and demand for the berries be unsurpassed, the reward is often considered worthwhile.

CONTROL OF BRAMBLE DISEASES AND INSECTS

With clean and healthy plants on land where brambles have not grown for several years and with the practice of good culture, the control of insects and diseases may not be a difficult problem for a number of years. The profitable producing life of the bramble planting may not be longer than from 7 to 10 years. At the conclusion of such a period, insect and disease control problems may have reached a point justifying the planting of a new patch or field where the fruits have not been grown in recent years. By rotating the planting to meet local needs, it is possible to avoid low yields and expensive and discouraging disease and insect control practices. To be on the safe side, however, it is generally advisable to adopt in the beginning a practical spraying program that may be used if and when needed.

HARVESTING CANE AND BUSH FRUITS

Brambles.—These fruits should be picked often during the height of the fruit ripening season. At the beginning, the picking of the fruit every 3 to 4 days may be sufficient, but as berry ripening increases, the entire patch may need picking each day. Bramble berries should be picked and placed directly into the box or cup in which it is handled and sold. Grading and sorting in packing sheds is not recommended as these handling practices are almost sure to do considerable injury to the berries. Marketable grades are picked directly into the packages and the soft and mashed fruit is either picked into separate containers or dropped on the ground. Harvested berries should never be left in the sun and dust.

Careful pickers place the filled receptacles in the shade of bushes, trees or the packing shed. Berries should not be picked when they are wet from rain, dew or fog. All the harvest at the close of the day should be rushed to market, the shipping station or cold storage. For picking the berries, basket carriers holding six or eight baskets and equipped with a pail are usually supplied the pickers. Carriers are often provided with short legs to avoid stooping and dropping the berries into the boxes. When the canes are loaded heavily with fruit, they may lie on or close to the ground. To prevent soiling the berries and to facilitate picking operations, forked sticks are frequently employed to prop up the canes while the fruit is being harvested. In picking the berries from thorny varieties workers often wear gloves from which the fingers have been removed.

COMBINED BRAMBLE SPRAY SCHEDULE

Delayed Dormant Spray

This spray is for the control of anthracnose, red spider and rose scale when present. Apply in early spring as growth starts. Use 11 gallons of

commercial liquid lime sulphur to make 100 gallons of spray where rose scale is present.

If the rose scale is absent, use 6 gallons of the lime sulphur to make 100 gallons of spray. Or use oil emulsion in Bordeaux 8-8-100 or equivalent commercial bordeaux with 2 per cent of dormant miscible oil. All the canes must be thoroughly wetted for effective results. This requires careful spraying work using sufficient pressure for good coverage.

Prebloom Spray

This spray is for the control of anthracnose. It should be made about a week before blooming occurs. Use Bordeaux 8-8-100 to which may be added 2 to 3 quarts of summer oil and ½ pound of soybean flour as a sticker and spreading agent.

Special Spray for Red Spider

During the hot, dry weather of late June or July, a special spray for red spider control may be needed. Use 2 to 3 quarts of a summer oil emulsion to 100 gallons of water. The first spray may be required during the latter part of June. If dry weather and injury continue, apply a second spray about 3 weeks later. A spraying pressure of 200 pounds for power outfits is suggested and as much as can be developed for hand sprayers. Thorough spraying, covering both sides of the leaves is recommended.

Spray for Leaf Eating Insects

If leaf feeding insects such as the sawfly worms or larvæ and others attack the foliage and new shoot growth, spray with lead arsenate (2 pounds in 100 gallons of spray) as soon as injury is found or about a week or ten days after the plants are in full foliage.

First Spray After Fruit Harvest

Soon after harvest a spray for the control of anthracnose on leaves and stems, leaf spot, and occasionally red spider is often applied. Use Bordeaux 8-8-100 to which 2 to 3 quarts of summer oil has been added.

Second Spray After Harvest

Following the cutting and removal of the old fruiting canes another bordeaux spray for the control of the pests mentioned should generally be made. Apply in about 3 to 4 weeks following the first after-harvest spray. Use the same materials and dilutions.

Tree Cricket Injury

The pale green to whitish green crickets with long feelers may be the most serious insect pest of brambles. The egg laying punctures in the

mature shoots in the fall cause the chief injury. If tree crickets are numerous, spray the shoots in early summer, or before the fruit is set using lead arsenate (4 pounds to 100 gallons of water). Keeping down weed growth in and about plantings and the removal of the wild blackberry, dewberry and raspberry from near the patches may help materially in the control work.

Cane Borer Control

Both the trailing brambles and the red raspberry particularly may be damaged seriously by the red-necked cane borer. After attack, the canes may show enlarged swellings $\frac{1}{2}$ to $1\frac{1}{2}$ inches in diameter and as much as 6 to 8 inches in length. All canes showing these abnormal swellings should be cut and burned during the fall and early winter. In so doing the overwintering grubs are destroyed.

Crown Gall

The difficulty of control and wide spread of crown gall makes it one of the most serious diseases of brambles. The bacterial malady appears as rough, spongy galls on the stems near the ground and on the roots. Eliminate all plants showing crown gall and purchase nursery stock from reliable dealers. No other effective control measures are known.

Orange Rust

This fungous disease is found most often on blackberries and dewberries but black raspberries are susceptible to attack. Once bramble plants are infected with orange rust they never recover and the disease appears year after year causing the plants to become unfruitful and to finally die. The entire plant including stems and roots becomes infected. Red raspberries may be immune to the disease or at least highly resistant. Orange rust may appear in late April or early May as small yellow dots spread over both surfaces of the leaves. A few weeks later large orange-red areas develop over portions or the entire leaf surface.

Control consists of digging up infected plants with as many roots as possible and burning in the spring. Since the disease spreads from wild brambles, these should be destroyed in locations near plantings. Also, resistant varieties may be planted. Additional information regarding spraying practices and insect and disease control may be secured by consulting Chapter 16, Disease and Insect Control.

THE CURRANT AND GOOSEBERRY

These fruits belong to the genus *Ribes.* The plants are native in the northern and cooler regions of America, Europe and Asia. However, they are grown throughout the United States but New York is responsible for about one-third of the currant acreage and other leading states in production are Michigan, Wisconsin, Pennsylvania and California. Also, import-

ant acreages may be found in the Willamette Valley, Oregon, and the Puget Sound district in Washington. Under irrigation both fruits are profitable in the Pacific Northwest and in the cooler sections of Colorado and Utah. These so-called bush fruits have perennial tops and include the gooseberry, currant, blueberry, cranberry, and closely related species.

CLIMATE.—Currants and gooseberries are classed as cool weather and moisture loving plants. Through the use of windbreaks and irrigation the fruits may thrive in the northern Great Plains region. Gooseberries are more resistant to heat and dryness and may be grown further south than the currant. The higher altitudes may offer greater opportunities for the culture of both fruits through the proper use of irrigation facilities.

LIMITING PRODUCTION FACTORS.—In the United States, the following factors may have curtailed production in some instances and discontinued it in others. Summer heat and dryness; deficient and undependable soil moisture; infestations of the currant maggot and the lack of effective control measures; and the prevalence of the white pine blister rust and the establishment of Federal and State Quarantine Controls.

The white pine blister rust is a destructive disease of five-leaf pines and gooseberries and currants, especially the black currants, are alternate hosts or food plants of the rust disease. The white pine is a valuable forest tree, and in most instances, may be more valuable than currant and gooseberry culture where white pine forests prevail. Naturally, therefore, Federal and State authorities usually choose the fruits for elimination or curtailment.

VARIETIES.—The red varieties of currants are generally preferred because they stand erect, have vigorous growth habits, produce abundant crops, and their culture is not difficult. Some of the most popular and widely planted varieties for the northeast are Perfection, Red Lake, Wilder, Red Cross, and White Imperial. For Michigan and the Central west areas, leading varieties are Red Lake, Wilder, Red Cross, London Market, and Perfection. The Pacific Coast states plant extensively such varieties as London Market, Perfection, Wilder, Red Cross, and Victoria. Black currant varieties of prominence are Naples, Climas, Magnus, Saunders and Kerry.

Producers generally grow the American varieties of gooseberries because they excel the European kinds in hardiness, production, and in producing fruits of high quality. However, the European sorts usually grow larger berries than the American varieties and sell readily, but the foliage and fruit is susceptible to the attack of the mildew fungus. Some of the varieties of gooseberries being planted widely over the country at this time are Poorman, Downing, Glenndale, Pixwell, Perry, Abundance, Clark and Fredonia.

YIELDS.—Production may depend largely on location, soil, variety, planting distance, season and care. On the average, a satisfactory yield for currants ranges from 150 to 200 bushels per acre, and for gooseberries from 200 to 400 bushels. In most cases the lower yields represent the European varieties and the higher the American. The average yield of an individual currant or gooseberry plant is about 3 to 4 quarts which represent a good yield under satisfactory conditions and the growing of suitable varieties.

PROPAGATION OF CURRANTS.—In propagating currants, hardwood cuttings are taken from the new wood during late fall, early winter or at pruning time in early spring. The length of the cutting is about 6 to 8 inches with the lower cut made just below a bud to facilitate healing. To prevent drying out of the top bud, the cut is usually made about one-half inch above it.

WHEN TO MAKE CUTTINGS.—The wood of last season's growth may be taken in the fall, winter and early spring months. There is no advantage in procuring the cuttings in the fall except to avoid winter-kill. Whether the cuttings are taken in the fall or spring, it is important that they be examined carefully to see that the wood is alive, mature, and capable of making root and shoot growth. Moreover, if rather firm, vigorous wood of the past season's growth is used for cuttings, much stronger and larger growth is usually obtained.

HOW TO MAKE CUTTINGS.—Cuttings are usually made from 6 to 8 inches long. A length of 4 or 5 inches may be very satisfactory. A sharp knife or shears may be used and care should be taken to see that the lower ends of the cuttings lie the same way in the grouping or bunching. If the cuttings are planted upside down, that is, with the top part in the soil, growth will not take place.

It appears that the position of the cuts in relation to the buds or joints is of little importance. If the top cut, however, is made through or close to the bud, drying out may involve the bud and prevent growth. The lower cut is often made fairly near the joint. To make cuttings rapidly for commercial purposes, the branches are bunched on a chopping block and cut into desired lengths with an axe or hatchet.

STORING.—Good results in the late fall or early winter should follow storing the cuttings horizontally in moist soil, sand, sawdust, sphagnum peat, or a mixture of sand and peat. For the first three or four months the best cold storage temperature seems to be about 50° to 55° F. and the remainder of the storage period about 35° to 40° F.

By subjecting the cuttings in the beginning to a temperature of about 50° F., callus growth facilitating root development is likely to occur, while the later cold temperature retards growth and breaks the rest period of the buds. Under such conditions, the tops should be ready in the spring for a rapid leaf and shoot growth and the roots for a strong development from the basal regions.

ROOT-INDUCING SUBSTANCES.—With good growing conditions or under controlled environment, the rooting of practically all kinds of cuttings may be facilitated by the proper use of growth promoting substances. Of the great number of chemicals used to stimulate root growth on cuttings, indolebutyric, napththoleneacetic, indoleacetic acids and their amide forms have been rated as the most effective and useful.

Such root promoting substances or hormones, are frequently defined as synthetic chemicals having hormone-like effects on cuttings that may stimulate the formation of roots. These complex organic substances are produced in seedlings, opening buds and in rapidly growing young leaves. It is believed that they initiate cell division in the cambium layer and promote general cambial activity.

The treatment procedure of the manufacturer should be followed carefully. This may consist of first moistening the lower or basal ends of the cuttings in water. The wet ends are then dipped in the powdered material of the container. As the cuttings are removed they are tapped lightly against the rim to remove loosely attached dust after which they are ready to plant. The openings in the planting media for the cuttings should be made large enough for the cuttings to be set easily at the depth desired without forcing. For the chemical to be most effective, it must go into solution on the stem. The greatest absorption is through the cut ends, leaf scars and to some extent through the bark.

Some types of cuttings that do not respond readily may be benefitted by re-treatment in about 3 to 4 weeks. Therefore, if cuttings upon removal in about a month show callus growth, satisfactory rooting may be induced by re-treating. It is usually advisable to work on a small scale until the methods adopted and the chemical used bring satisfactory results.

PLANTING.—Plantings should be made in the spring as soon as soil and weather conditions will permit. Rows may be laid off with a plow or hoe at the distance desired. It is important that the soil be firmed about the base of the cutting to facilitate root development. One and one-half or 2 inches, including at least one bud, should be left above the surface of the soil.

Late fall or early winter preparation of the soil for spring planting usually produces the best results. The cuttings may then be planted early in the spring while the soil is too wet for stirring. If the ground is fairly smooth, the rows may be marked off 24 to 36 inches apart by stretching a string from stakes driven into the soil. The cuttings may then be pushed into the soil by the side of the string at 6 to 10 or more inches apart, leaving only an inch or two above the surface of the soil. This method of planting is generally more rapid and since the cuttings are pushed into the soil, the bottom parts from which root development starts are likely to be in close contact with the soil particles, which tends to cause rapid root growth.

GROWING.—The cuttings should be given timely cultivations from early spring until mid-summer to keep down grass and weeds. In dry periods many cuttings may be saved by irrigating at intervals of 7 to 10 days until rains are ample. Cultivations should follow irrigations as soon as the soil is suitable for working.

PROPAGATION OF GOOSEBERRIES.—Gooseberries are propagated by both cuttings and layering. The making, handling, storing and planting is in general the same as for currant cuttings. Two methods are used in layering gooseberries. If only a few plants are needed, convenient branches while still attached to the plant, are bent down into a shallow trench, and covered with soil leaving a few of the ends of terminal branches exposed or above soil. The branches may be weighted with a stone or additional soil. Also, hooked pegs forced into the earth may anchor the canes. The work may be done in the fall or early spring. After one season of growth the layered stems should be rooted sufficiently for setting in nursery rows. Slow rooting varieties may require another year of growth before enough roots have developed for transplanting to the garden.

For quantity production, mound layerage is employed. During the dormant season, the main branches of established bushes are cut back severely. In late May or early June soil is drawn up around the base of the clumps and sifted among the stems until approximately half the length of the cut-back stems and new shoot growth is covered. The earth mounding work is done with plows, spades, hoes and other implements. The soil is firmly packed around the plants, and it is well to cover the mound with a mulch of straw, sawdust, leaves or old hay. After one or two seasons of growth the rooted stems are separated, severed and transferred to nursery rows or planted directly in permanent locations.

Cultural Practices

The cultural practices of currants and gooseberries are in general quite similar to those of brambles. This is true for soils and sites, planting, cultivating and mulching, fertilizing, pruning, disease and insect control, and the handling of other growing problems. The reader is referred to the discussions of appropriate subjects under the heading of "Growing Cane and Bush Fruits" in this Chapter.

Harvesting Currants and Gooseberries.—During periods of hot weather currants may be damaged from scalding. By making two pickings, loss from this cause may be reduced markedly. When the berries of the clusters have developed a bright red color, the proper picking condition has been reached. In picking, the berries are not separated from the stem as the clusters should be picked whole. This suggestion is important, because berries picked from the clusters, may damage all the fruit in the package by causing it to become moist from the juice exuding from the injured berries. Under such conditions spoilage or decay may proceed rapidly.

Little or no injury occurs in picking and handling gooseberries as the fruit at harvest time is still hard and green. On large acreages, the berries may be harvested by stripping the leaves and fruit from the stems into a shallow box. The berries are then separated from the leaves, broken stems and trash by running the fruit and strippings through a fanning mill, which blows out the waste materials, leaving the fruit free. Another method consists in holding a portion of the bush in a gloved hand while picking with the bare hand.

BLUEBERRIES

The family of blueberries (genus *Vaccinium*) includes all the plants known as blueberries, billberries, deerberries, and cranberries. In some regions they are all known as blueberries, while in others they are collectively called huckleberries. In the New England States, where the crops are native, color distinguishes one group from another.

HUCKLEBERRIES
(Genus *Gaylussacia*)

Huckleberries are black in color and each berry contains about ten hard nutlets or seeds which may be very noticeable when the fruit is eaten.

In comparison, the blueberries contain a large number of small seeds which are soft and hardly perceived. Another striking difference between huckleberries and blueberries is the presence on the leaves of the huckleberry of resinous dots which give the leaves the appearance of being blotched as though with varnish.

The two main types of blueberries are the low bush blueberry which is usually found growing on uplands, and the high bush blueberry which is more frequently found in swamps. In both of these groups there will be found a number of quite different species.

SOIL REQUIREMENTS.—Blueberries are adapted to acid soils only. The most desirable soils are light, preferably sandy, with a considerable admixture of humus derived from leaves and other materials. The soils used for the growing of ordinary garden crops are unsuited to blueberries unless modified properly. In general, the best method of determining whether or not the soil is suitable for blueberries is a study of the vegetation found upon the land. It is highly important that commercial plantations be attempted only upon land which is naturally adapted to this plant.

The varieties of blueberries which lend themselves best to garden culture are of the high bush type. These may be grown under swamp conditions; yet this is not necessary or even desirable, as the land must be well-drained during the growing season in order to secure good results. An abundance of moisture is necessary while the fruit is maturing.

PROPAGATION.—To propagate blueberries, the tops of the bushes are cut off early in the spring to within a distance of about 2 or 3 inches of the ground level. In digging, the clumps may be divided so that each may have some roots attached. In performing this work, a saw or sharp hatchet may be needed for separating the plants. The plants are then set out in suitable nursery rows where they are given abundant water and kept cultivated and free from weeds.

CULTURE.—For commercial plantings the nursery stock is set about 4 feet apart in rows 8 feet apart. Good cultivation with plows, supplemented by hoeing, will be necessary to keep down weeds. While blueberries will succeed in very poor soils, yet fertilizers will produce a stronger growth and cause the plants to be more fruitful. The following fertilizer has been used with good results:

100 pounds nitrate of soda
250 pounds finely ground rock phosphate
50 pounds sulfate of potash

Such a fertilizer may be applied at the rate of 350 to 400 pounds per acre. For home use blueberries are frequently set on the square plan 4 feet apart and mulched with straw, shavings or similar material. It is desirable usually to add a new mulch each year. Barnyard manure does not prove satisfactory as a mulch. With soils which are suitable, the blueberry may be easily and profitably grown.

VARIETIES.—The largest quantity of blueberries appearing on the market comes from wild bushes. Better sorts have been selected from the wild and hybrids of these are now grown in some of the larger nurseries. The

United States Department of Agriculture, cooperating with the Agricultural Experiment Stations, have been largely responsible for the origination and introduction of several promising varieties. The industry is now in the experimental stage and should not be attempted on a large scale until the grower has had practice and information in the growing, harvesting and marketing of the crop. Some of the leading varieties are Cabot, Adams, Pioneer, Rubel, Dundee, Grover and Harding.

CRANBERRIES

Cranberries (*Oxycoccus macrocarpon*) belong to the family *Vacciniaceæ* Unlike the other bush fruits, this is a highly specialized crop, the production of which is confined to a comparatively few regions. About half of the crop is produced in Massachusetts; over a third in New Jersey; and considerably smaller acreages are found in Wisconsin, Oregon, Washington and Nova Scotia. Although a comparatively new industry, it has developed rapidly in the past 25 to 40 years due to improved practices in cultivation, harvesting, grading, packing, and marketing. The demand for the fruit is generally excellent. In those sections where cranberries can be properly grown, it is obvious that this is one of the specialized branches of agriculture which has been to a large extent neglected.

Characteristics.—The cranberry plant consists of trailing runners having numerous erect branches and roots distributed over its length. Both the runners and the uprights bear leaves but only the uprights bear fruit. The fruit buds are terminal and first appear in August. The leaves turn red in winter and green in spring. The plants flower in late June or early July and bear ripe fruit in September or October.

Varieties.—The varieties are distinguished by differences in the character of the fruit produced and in the time of ripening. Some fruits are cherry-shaped; others bugle-shaped; and still others bell-shaped. The color may also vary from light yellow to a very dark red. There is a considerable variation in size. Some of the best varieties grown in the various cranberry-producing districts are as follows: Hawes, Early Black, Jersey, Centennial, Champion, and other sorts.

Soils.—The cranberry plant is one of the most exacting as to soil requirements. The top layer should be an acid muck or peat varying in thickness from a fraction of an inch up to 10 to 20 inches. The second layer usually consists of sand of varying thickness. This is underlaid by hardpan which is generally impervious to water. The chief varying factor in cranberry soils is the thickness of the muck. It is found that the thicker the muck, usually the better the soil is suited to the production of cranberries.

Cranberry Bog Construction.—The site for the cranberry bog should be cleared of all vegetation. This is accomplished by cutting away the trees and underbrush and usually by flooding the land for a couple of years to kill out all plant growth. The flooding is accomplished by building dams with proper gates and backing the water up sufficiently to cover the area used. Highly specialized methods are employed in the construction of the bog, the details of which will not be given here.

PLANTING.—Cranberry vines are propagated by means of cuttings. For commercial purposes, the vines selected for use are mowed off in the spring before the terminal buds break open, and the cuttings obtained are set out in the new location. It is important that the cuttings be handled and planted without any drying out. They are set in rows 12 to 20 inches apart, and 6 to 15 inches apart in the rows. Young cranberry bogs usually come into bearing about 3 to 6 years after planting. When the plants have once come into bearing, the purpose then is to keep the plants in a healthy condition by regulating and controlling the moisture, controlling pests, etc.

HARVESTING.—The harvest season begins in September and lasts until late in October. The berries are both hand-picked and scooped. Machines are also used for harvesting in some of the commercial districts of the country. Scooping has many advantages over hand-picking, as the harvest can be accomplished more quickly and with less help.

STORING AND PACKING.—The berries remain stored in crates until sales are made. As little handling as possible is given on account of the danger of injury, which may be followed by rotting. Cranberries are sorted by machinery. The fancy grades of the crop require special handling.

FERTILIZERS.—In some of the bogs, nitrate of soda and superphosphate are valuable fertilizers. In most cases, however, complete fertilizers are used. The American Cranberry Growers Association suggests the following fertilizers: Sodium nitrate 75 pounds; dried blood 75 pounds; rock phosphate 300 pounds; and sulphate of potash 50 pounds. Amounts used per acre range from 200 to 500 pounds.

Chapter 12

Some Native Neglected Fruits

NATIVE neglected fruits such as the persimmon, pawpaw, crab apple, plum, blackberry, raspberry, dewberry, huckleberry, blueberry, elderberry, strawberry, grape, and others are termed "Neglected Fruits." For some reason these fruits *have not arrived.* Most of these still grow mainly in the wild or uncultivated state. Nearly all possess special tastes, flavors, aromas, colors and still other distinctive and definable characters that are enjoyed tremendously.

Just why fruits having the merits that many of these possess should continue to grow in the wild state for so long with little or no mention or serious consideration is worthy of study. Of course, some may brush the question aside with the remark that the fruits are not of much value or the desirable ones would have been brought into general use and cultivation long ago. Others may as stoutly maintain that none of these so-called neglected fruits equal for our purposes the kinds and varieties we are already using and have placed under a high state of culture.

Nevertheless, it may be said that few of these wild fruits have been tested thoroughly for their food values alongside the kinds and varieties we now know fairly well and that might be supplemented to advantage. There seems to be a wide open field for productive research with the neglected fruits, particularly in plant breeding and selection for improved kinds. Modern refrigeration makes species and varieties in demand the year round and new techniques and methods of processing plants have enhanced the food values of many that were formerly considered mediocre or worthless.

OPPORTUNITIES FOR IMPROVEMENT.—Plant breeders are generally of the opinion that there is undoubtedly a promising field or opportunity for additional work in hybridizing our fruits, especially those of native origin and that may be termed neglected fruits. The chief drawback or danger is that the persons interested in the creation of new varieties are likely to expect too much from hybridization and entirely too little from the improvement of all the other conditions and factors which materially modify plants. Also, it should be understood that rather difficult or so-called violent hybridizations usually produce disappointing or unreliable results. Subsequent crossings, however, with the original species and hybrids may be expected to have a tendency to correct or overcome some of the adverse results.

Other Factors of Interest.—It is common knowledge that we have already found and developed markedly those groups of native fruits in which the greatest improvement has been made. However, we are aware of the fact that there still remain various types that may become tremendously important through modern methods of hybridization and selection. This will be made apparent at once to those that take the time to review the literature now available on the evolution, introduction and improvement of our native and cultivated fruits.

Fig. 29.—A close view of branches of the Josephine persimmon tree showing the fruit still attached, November 30, 1949. (Mo. Agr. Exp. Sta.)

Studies of our native fruits are sure to impress everyone with their great abundance and opportunities for extension and amelioration. The species which are considered in this discussion represents hardly a good beginning of a study of the whole number of promising indigenous kinds.

The unusual wealth of our native fruits attracted marked attention of the early explorers and colonists. Voluminous accounts and records of

these early impressions dealing with the vast number of kinds and varieties are interesting and valuable.

For example, William Wood, in 1634, speaks of the berries in the wilds of Massachusetts Bay, as follows: "There is likewise Strawberries in abundance, verie large ones, some being two inches about; one may gather halfe a bushell in a forenoone: In other seasons there bee Gooseberries, Bilberries, Treackleberries, Hurtleberries, Currants; which being dryed in the sunne are little inferior to those that Grocers sell in England."

Travelers often marvel and comment in reference to the abundance and high qualities of native fruits in many parts of the cold north and the deep south. The more temperate regions are equally favored in this regard.

OBJECTIVES.—This chapter, therefore, will be devoted to a brief consideration of some of the neglected fruits. The purpose will be to point out, from the knowledge we now have, a few, at least of the main characteristics of the plants and their potential values and possibilities for development.

Also it is hoped that the foregoing information and brief descriptions of some native neglected fruits may arouse the investigative spirit and enthusiasm of those interested in the further development and improvement of fruits. Some knowledge of the varieties and species and their origin, history and habits of growth should be understood. Adaptations of soils and climates and their relation to fruit pests and the purposes for which they are best fitted is of equal importance.

THE NATIVE PERSIMMON

(*Diospyros virginiana*)

The native persimmon is believed to have been the first American fruit to be described and praised by the early European explorers. De Soto recognized its high food value in 1539 and in 1557 published an account of the tree and fruit. Jan de Laet in the following year, described the persimmon in his writings on Virginia. A long and interesting discussion of the fruit was made in John Smith's narrative dealing with the settlements and resources of the New World during the early years of seventeenth century. One statement regarding the persimmon from this production is significant and holds true today "If it be not ripe, it will draw a man's mouth awrie with much torment." The tannin contained in the immature or unripened fruit causes the astringent taste and puckering effect.

CHINESE-JAPANESE PERSIMMON

Diospyros Kaki, the Chinese-Japanese persimmon, is generally known as the Kaki or oriental persimmon. It has been under cultivation for centuries and is much more improved than the native varieties in the United States. Although test plantings of the Kaki have been made in most sections where there appeared to be possibilities for successful culture, the fruit has not been widely grown. Perhaps it succeeds best and is most appreciated in California. Here it is grown fairly extensively for commercial

fruit production and in the home fruit garden for home and local uses.

In general, the Kaki seems to lack hardiness or resistance to winter cold. This factor alone appears to be the one that has tended to check and prevent wider and more extended plantings. It is possible, therefore, that our native persimmon may have much greater merits for improvement through breeding and culture than the Kaki.

The oriental variety has much larger fruit than our native sorts and it may be successfully budded or grafted on any of the common native persimmons. The grafting work may be done during the early spring as growth starts. The month of June has been found to be a very favorable time for budding.

NATURAL DISTRIBUTION OF NATIVE PERSIMMON

The native persimmon is found wild in most of the southeastern quarter of the United States and as far north as 38° latitude. It will thrive and ripen its fruit as far north as the Great Lakes, Michigan and New York. West and southwest Missouri, southern Iowa and eastern Nebraska appear to be favored sections for good growth and fruiting. Few trees are found west of central Kansas, and Connecticut and Rhode Island marks the main limits of distribution in the northeast.

Some Advantages of Culture

Although the native persimmon is one of the surest cropping edible fruits we have, it is not generally regarded highly among our common fruits. This is perhaps true because the fruit may be found growing abundantly in almost every section. One is usually able, therefore, to produce it with but little effort and without great cost. There is often more appreciation for products when we have to pay a high price for them. The persimmon tree comes into bearing at from five to seven years of age, a little earlier than apple trees. They are resistant to cold, thrifty, symmetrical in form and are sturdy but slow growing trees. Very little pruning is required. The fruit, foliage, branches, trunks, and roots of the trees are rarely injured seriously by injurious insects or fungous diseases. Spraying, therefore, is usually of much less importance than for other fruits.

Cultivated Named Varieties

The cultivated and named varieties of the native persimmon have originated as chance seedlings. Nearly all of these seedling sorts produce fruit of the oblate type or flattened and depressed at both ends. The names of some of the chief varieties follow: Boone, Early Golden, Golden Gem, Josephine, Kansas, Miller and Ruby.

Pollination Requirements.—The native persimmon trees may bear both male and female flowers or these flowers may be borne on separate trees. When both kinds of flowers are produced on the same tree, pollination is simplified and one tree is all that is required for fruit set and production. On the other hand, if the staminate (male) and pistillate (female)

flowers are borne on separate trees, then both kinds are needed for pollination, fruit setting and development.

The pistillate or fruit producing flowers are borne singly and the staminate or pollen bearing flowers are usually grown in clusters of three in number. While the pollen is generally distributed by honeybees, it may be carried by the wind from tree to tree as it is light and powdery. There is a tendency for fruit to set without pollination and the development of fruit without seeds. Seedless fruits, therefore, are frequently found.

THE PERSIMMON AS A TREE CROP

Brief Summary.—It is believed that there are at least 200 species of persimmons distributed about the world. For both the plant breeder and the plant hunter, perhaps no more fertile or productive opportunities for service to agriculture can be found. Furthermore, it is possible that crops may be produced, through improvement and selection, that might rival in usefulness and value corn, apple and orange crops.

Wild native persimmons may be found in abundance from East Texas, through the Ozarks, southern Iowa, southern Indiana, and central Tennessee. Equal growth, production and possibilities of the native fruit are also found in north Florida, central Georgia, North Carolina, Virginia, southeast Pennsylvania, Connecticut, and Rhode Island.

Trees from seed may bear as much as a gallon of fruit in 3 or 4 years after planting seed. Mature trees of 25 or more years of age may produce about 5 to 6 bushels of fruit per tree. The fruit of the persimmon tree is considered the most valuable for livestock of the various types of any forest tree. This may be particularly true for pigs, cattle, horses and mules. A point especailly favorable to the persimmon is that the leaves of the plant are distasteful to pasturing animals. Rarely is the foliage damaged even by sheep and goats unless there is a considerable shortage of grazing plants.

The trees usually bloom late in the season. This is generally insurance against damage to the fruit by late spring freezes and frost. Few tree crops are as free from injury by insects and diseases. Rarely are spraying or dusting practices needed and the twig girdler can be controlled effectively in most instances by the prompt removal and burning of the fallen branches. As the persimmon produces a tap root and the shade formed by the foliage is less extensive for the comparatively small trees, most crops may grow successfully when planted fairly close to the trees.

Farmers often maintain that the fruit of the persimmon is almost equal in value to corn for pigs, cattle, horses, and mules. Furthermore, a succession of varieties ripening their fruit and holding it on the twigs from about mid-August to January may furnish a nutritious and dependable harvest or food supply for 4 or 5 months. Comparatively little if any care is given the average persimmon grove, yet under such neglect some producers everywhere have words of praise for the native persimmon.

NATIVE CRAB APPLE

Five different types of native crab apples are found in North American woods, along roadsides, in abandoned fields, and elsewhere in the wild.

Some new varieties have been produced by crossing these with cultivated apples, or their seedling offsprings. However, comparatively little concentrated work or planned improvement projects have been undertaken to promote or encourage the use and improvement of crab apples. Certainly there is promise of the creation and development of varieties of apples possessing greater hardiness of tree and longer keeping qualities of the fruit by further crossings and selections with the common apple.

FIG. 30.—Hawthorn, Haw Tree (*Crategus molles*) valuable for its handsome foliage, attractive flowers, and decorative fruit which, in this species is edible. (Mo. Agr. Exp. Sta.)

THE PRAIRIE CRAB

(*Pyrus Ooensis*)

This is one of the most promising native crab apples. It is found from Louisiana and Texas to Oklahoma, Wisconsin and Minnesota. It thrives in the upper Mississippi Valley which is a test of its hardiness and productivity. An accidental cross in the wild has given rise to the Soulard crab apple. The tree is an excellent grower, regular in bearing and regarded as a very promising apple for the severe cold of the prairie states. Several improved varieties have originated from the Soulard apple.

THE WILD CRAB

The wild crab apples of the Mississippi Valley and eastward are generally divided into two species. One is known as the Garland crab (*Pyrus coro-*

naria) of the Northeast and the other narrow-leaved crab (*Pyrus angustifolia*) of the South. These wild crab apples may brighten the roadsides, fields, and hills with their rose-colored and attractive blossoms. They are found from the Great Lakes to Texas and Alabama. In the wild, on the home grounds or in public parks, the little trees clustered together and exhibiting flat and more or less matted tops enhance the landscape. The immature green apples were used by the pioneers for the making of jellies, jams and perserves. Still earlier, the Indians gathered and dried the fruit for fall and winter uses. Some people at the present time continue to use the fruits for jellies, preserves and the like because of the distinctive tangy and spicy flavors.

(*Pyrus coronaria odorata*).—This crab is found growing on glades and other unfavorable sites from New York to Michigan, south and west to Missouri and Kansas and perhaps to Georgia. It is small, slow-growing, thorny and spreading in type of growth. Although an interesting and attractive little tree, it has not been put to a great deal of use. It nevertheless deserves further study and an opportunity for improvement to better serve our needs.

THE OREGON CRAB (*Pyrus rivularis*).—This crab apple has not been placed under cultivation as yet for its fruit. Its range extends from Alaska to California. Of all the crabs, this is the largest species of native apple tree. It may grow to a height of 25 to 40 feet. The trunk of some trees may have diameters of as much as 10 to 12 inches. The species resembles the Siberian crab more than the other native crab apples of North America. The tops of the trees are spreading and they may produce heavy crops of oval shaped fruits, of a golden color when ripe. During the earliest times the fruit was eaten by Indians and the early settlers used it for jelly making and other purposes.

NATIVE AMERICAN PLUMS
(*Prunus Americana*, Marsh)

It is generally believed that the wild native plums of the northeast and extreme west, while of the same species as those of the middle western prairie states, do not appear to possess so many forms or kinds that bear large attractive fruits. However, the European plums, are more fruitful and profitable when grown in the west and northeast than the native plums. Consequently fruit growers of these sections have given the native fruits little attention. However, native plums continue to be propagated and planted extensively in some sections.

Many American plums are superior for certain cooking purposes and in the states of the middle latitudes they are still the most profitable market plums produced. Furthermore, all are in need of substantial improvement although relatively hardy and satisfactory for withstanding the severity of northern and central winters. From Virginia southward European plums do not thrive and there is a growing interest in the improvement and cultivation of native plums.

In general, American plums are early and heavy bearing. On account of the likelihood of a need for hardiness they are usually propagated on

American stock. They usually require a minimum amount of pruning but need careful and timely spraying for the production clean, wholesome fruit. The (*Prunus nigra*) group have a few varieties rated highly for their hardiness. Cheney and Aitkin are good examples and are adapted to northern sections. They usually bloom earlier and fruit less heavily than the Americanas.

(*Prunus munsoniana*) includes the Wild Goose group with such varieties as Milton, Wooton and Whitaker. These varieties are suited to planting in the central region or for such states as Kansas, Missouri, Tennessee, Kentucky and Maryland. The Chickasaw varieties (*Prunus angustifolia*) are adapted to the southern states. They may be propagated on any kind of plum stock but possess the bad habit of suckering when they grow roots of their own. Practically all the native plums require cross-pollination for fruit setting and development. They are generally inter-fertile, that is, one variety may pollinate any other variety, if they bloom near the same time. It is important, in securing fruit sets and good cropping that varieties blooming at the same time be planted together.

Nearly all the native plums develop into small trees. They may as a result be planted somewhat closer together than some other fruit trees. Generally a spacing distance of about 24 to 30 feet at planting time will prove satisfactory. As a rule plum orchards give the best results when the soil handling methods consist of clean cultivation and the use of cover crops. Usually native plums require less cultivation and fertilization to maintain vigor and fruitfulness than European plums.

THE NORTHERN PAWPAW
(*Asimina triloba*, Dun.)

The pawpaw is one of the most typical neglected fruits. It may be found growing wild from Florida to Louisiana and northward through Indiana, Missouri, Eastern Kansas, Iowa, Michigan and then eastward to New York. Trees as well as the shrub-like growth of several stems that may arise from a central crown are generally found on river or creek bottom soils. Partially shaded sites under tall trees often apppear to be favored areas for the best growth of the plants. Apparently the higher the fertility of the alluvial bottom lands, the greater the response of the pawpaw in growth and fruitfulness.

The trees although usually small, about 12 feet high, may reach under favorable conditions heights of 20 to 25 feet with a trunk circumference of 4 to 5 feet. Furthermore, the trees and bushes may live 50 or more years and bear all the way from a few fruits to as many as 40 to 60 or more per plant nearly every year after reaching fruiting age.

The shape and color of the fruit remind one of the banana. Consequently it has been called the "wild banana tree." The attractive fragrance and flavor of the fruit is valued highly by many people especially in the central and southern states. The leaves have a tropical appearance. They occur on rather short, thick stalks and the single blades are 8 to 12 inches long and about 4 to 5 inches broad. The surfaces of the leaves are glossy in

appearance. They are set alternately upon the twigs, and cluster in whorls on the ends of the branches.

The flowers are unique and appear with the leaves. In fact, were it not for their abundance and the rather striking and unusual color of the three large membranous petals they might possible escape notice. When the axillary blossoms first appear they are as green as the leaves and may not be recognized as the flower parts. However, the color changes from shades of brownish green to an interesting and attractive dark, rich wine-red color. As the flowers and foliage develop the trees are characterized by a distinct and marked odor which is generally considered agreeable.

Fig. 31.—Fruits of the pawpaw bush or small tree. It may be found growing in the wild on creek and river bottom lands and elsewhere on the better types of soil. It ranges from the central states southward and eastward to the Atlantic Coast. The fruit and foliage are attractive and distinctive and the pawpaw may be well suited for the lawn and home fruit planting. (Mo. Agr. Exp. Sta.)

The pawpaw lends itself well indeed to planting on home and public grounds. This is particularly true where there is a need for a small specimen tree or one for general purposes. While the tree may differ considerably from some shade and ornamental trees nearby, yet that difference is not so marked or striking as to give the pawpaw the appearance of being out of place. Usually the opposite effect is produced as the size of the tree and, its slightly different appearing flowers, fruits, and foliage seems to fill a nick or corner and tends to harmonize the garden or lawn picture.

HUCKLEBERRIES
(*Gaylussacia*, Supp.)

The huckleberry is closely related to the genus *Vaccinium*. In fact, the plant was one time included in the genus because it is much like the group. Since there are genetic differences pronounced enough to warrant separating

the two forms, botanists have usually found it convenient in recent years to separate the species. In North America five different species of the huckleberry are found. Four of these yield fruits which are highly prized for their flavors and usefulness for pies, jams, jellies and the like.

On account of the hard seeds common to the huckleberry it is not rated as popular as the blueberry. However, there is a great variation in the size and hardness of the huckleberry seeds. It is believed that under cultivation forms could be selected with fewer, smaller and softer seeds. With the one exception, hard and fairly large seeds, the huckleberry has as pleasant a flavor and it is as palatable as the blueberry. In spite of the seeds we find huckleberries, are in demand on the markets and usually sell for satisfactory prices. The efforts to improve huckleberries have been so limited and so few in number that we do not know at this time how the plants may respond in growth and fruitfulness to modern methods of cultivation. The difficulties that may be involved in domestication are not likely to be greater with the huckleberry than with the dewberry. It is well known that the huckleberry does respond favorably to better environment. Several species show great differences in size, color and flavor depending upon the soil, moisture, light and the individual plants concerned. There is a real opportunity, it is believed, for great improvement of the huckleberry for cultivation through selection and hybridization.

BLUEBERRIES
(*Vaccinium*)

The attempts to domesticate blueberries and huckleberries have failed to be as successful as anticipated. Species of both berries, however, are under the process of domestication. In the beginning many failures to succeed with these berries were due to the fact that growers and handlers failed to recognize the fact that the plants may not thrive on soils which are distinctly alkaline or neutral in reaction. When the berries are grown only in acid soils they may thrive but only fairly recently investigators have found that there is an association between the berry plants and a root-fungus. Apparently this root-fungus is required for good growth and fruitfulness. The trials and tests now being performed show conclusively that under proper conditions with an acid soil and the root-fungus, these fruits can be cultivated profitably. Both are notorious in that they have developed through the past, thrived and produced crops of fruit on waste land including pine plains, swamps, uncultivated and cut-over timber lands, abandoned fields and pastures. Improved varieties of blueberries and huckleberries somewhat comparable to our other fruits would add much to fruit growing throughout the country. Even as these berries are today they rank among the best of small fruits and are considered the most valuable and promising wild fruits of this continent. The crops sell for several million dollars annually, even under neglect.

Blueberries rank high among the small fruits and they are believed to be valuable and promising wild fruits. They contain many soft seeds and differ from the so-called huckleberries which have ten large bony seeds.

According to the 1940 census, Maine had 83 per cent of the total blueberry acreage of the New England States. This included about three-fourths of all the native wild blueberries harvested in the United States, and about two-thirds of the total acreage of all wild and cultivated blueberries. Furthermore, the 1950 census showed substantial increases in production in a number of areas. The reported volume harvested in Maine in 1940 was about eight times larger than in either New Jersey or Michigan which ranked second and third in production. The blueberries of New Jersey consist chiefly of the high bush, cultivated and named varieties, while the Michigan berries are mostly from the wild varieties as is true in Maine. The several species of wild low-bush blueberries hybridize freely. Many different kinds, therefore, may be found growing together as blueberries spread from underground shoots known as "clones."

Because there was an abundance of wild berries, no effort was made to develop improved varieties until about 1906 when Dr. F. V. Coville of the U.S.D.A. initiated cultural and varietal improvement programs. Much additional and important work has been carried on by the Government in recent years. Different species of the berries are found growing naturally from the low moist bog land in New Jersey to the high and relatively dry uplands of Maine and Georgia. Acreages are also found in North Carolina, Massachusetts, New York, Washington and Oregon.

THE STRAWBERRY

The genus *Fragaria* to which the strawberry belongs is widely extended. It grows most abundantly in the temperate clmates, yet many different forms have been found in the tropics and to the borders of the arctic regions. Indigenous species are also found on every continent and large body of land. Naturally, the species being so widely distributed, great variability among them is a marked characteristic. More than 150 names have been applied to the different forms. However, the cultivated kinds are believed to have been derived from four species.

Both staminate and pistillate varieties may occur in the wild. However, in most cases the different sorts are likely to bear both kinds of flowers and be capable of self-pollination and able to supply pollen for cross-pollination if it is needed for pistillate kinds. If functioning stamens and pistils are not found in the same flower, fruits may not set and grow unless pollen is brought from the flower of another variety. Pollination or the spread of pollen from flower to flower is usually accomplished by honeybees.

1. *Fragaria virginiana*, Duchesne is known as the Virginia or Scarlet strawberry. This fruit is not only found in every state in the Union but from the far north in Canada to the mountains of Mexico toward the South. As one would expect, the species is found in many different forms. Several of these have been given names. Notable in the list is var. *illineonsis*, Gray. It is subject to marked changes and is considered worthy of further study.

2. *Fragaria chiloensis*, Duchesne is found in both North and South America. It is the common strawberry growing in the wild from Alaska

to California, and from Peru to Patagonia. Like other strawberries distributed widely, there are many striking variations. No doubt many of these offer excellent opportunities for development through hybridization and selection. Nearly all the varieties cultivated in America are allied in lineage to this South American form. This Chilean strawberry is responsible for the large size of the varieties we are now growing. The large-fruited Pine var. *Ananassa* is perhaps a cross between *F. chiloensis* and *F. virginiana*. The name "Pine" has resulted from the pineapple fragrance of the fruit.

3. It is well known that *Fragaria ovalis*, the Rocky Mountain strawberry, may be crossed with the cultivated varieties. It is also possible that it may have value as a parent plant.

THE BRAMBLE FRUITS

Like some of our other common fruits, the brambles are not entirely neglected. However, there are so many wild species and types that it seems advisable to consider these fruits along with others that are very much neglected. The brambles belong to the genus *Rubus*. The fruits of brambles are known by all as berries. Furthermore, the fruit of the brambles is an aggregation of drupelets and each drupelet is a carpel. The drupelet in blackberries and dewberries adhere to the core or torus while in the raspberries the mass of drupelets separate from the torus and form a hollow cup-like fruit.

Some of the most common varieties of the black raspberries are Gregg, Ohio, Kansas and Cumberland. Similar red varieties consist of Latham, Chief, Brilliant, Antwerp, Cuthbert and others. The purple kinds are hybrids between native red raspberry and black raspberry. They also occur both naturally and under cultivation. Perhaps the Columbian is the most sought of the purple raspberry. This is due to its large size, firm flesh, handsome appearance and the splendid quality of the fruit.

The possibilities for improvement may be great not only from crosses but from the selection of promising and fruitful sorts growing in the wild. The sowing of seeds and making careful selections may also prove profitable.

NATIVE BLACKBERRIES

All of the common garden blackberries have been derived from several native species. Perhaps no fruit offers as great a number of endless varieties as wild blackberries. Some important varieties of blackberries are Early Harvest, Alfred, Ward, Blowers, Snyder, Eldorado, Lawton, Agawam, Ancient Briton, Taylor, Mersereau, and others. On the Pacific Coast the Himalaya, Mammoth and Evergreen are important types. A trailing blackberry is known as a dewberry. It ripens its fruit earlier than blackberries. There are also other differences between dewberries and blackberries. The dewberries were more recently domesticated than blackberries. In fact some authors do not even list the dewberry as a domesticated fruit because so little has been done toward the improvement

of the plant. In many cases the fruits are larger, more attractive and better flavored than blackberries. Also they may be more productive but the fruit is often soft and difficult to handle. Increasing numbers of varieties are under cultivation and these will undoubtedly give rise to more important and more useful varieties. Lucretia is the best known and most widely grown of all dewberries.

AMERICAN NATIVE GRAPES

All the grapes belong to the genus *Vitis*, of the vine family *Vitacea*. The wild varieties of American grapes and their hybrids with the European sorts are the parents of the commercial types now being grown. These are known as the American grapes and of the more than 20 native species in the United States and Canada, one-half or more have been domesticated or are now under cultivation and observation.

It is indeed interesting to note that North America is considered the most prolific in species of *Vitis*. Moreover, these species range from Canada to the tropics and from the Atlantic to the Pacific Oceans. The native species that has been most improved is *Vitis labrusca* of the Atlantic slope. Perhaps, this is not because it has more merit, as some of the southwestern species appear equal or superior for domestication. This *Vitis labrusca* species is made up of such varieties as the Concord and Catawba types. Undoubtedly the species has been hybridized with *Vitis vinifera*, the Old World grape and varieties like Barry, Lindley, Delaware, Agawam and others are the result.

Furthermore, it is believed there are great possibilities of amelioration to come from work with the species known as *Vitis æstivalis* from which several of the most important wine grapes have originated. The Muscadine (*V. rotundifolia*) of the South has produced the Scuppernong and other well known types. Of the wild species, some of the best and most promising have not yet been considered seriously for improvement. As interest in plant improvement grows and the needs come to light for better varieties, steady and certain progress will be made.

Some of the best authorities on grapes and grape culture are of the opinion that this fruit is now in need of improvement more than any other. It is pointed out that the types now grown are still much inferior to the Old World types. The commercial varieties such as Concord, Niagara, Worden, Catawba, Herbert, Norton's Virginia and others are more or less general-purpose grapes. Usually the markets are over-supplied with these sorts.

There appears to be a demand and considerable interest for special varieties to meet particular needs such as juice grapes, wine grapes and fresh fruit grapes for immediate consumption. Still other special needs like jam, jelly and marmalade making may be met more adequately with special varieties suited to the purposes. Although there is a need for further improvement of the domesticated native species, there is even greater interest in the improvement of such species, as *Vitis linceeumii*, *Vitis champini* and the like.

Chapter 13

Controlling Rodents Harmful to Fruit and Vegetable Crops

DAMAGE by rodents to all fruit and vegetable crops may occur nearly every year in certain localities. The chief offenders may be rabbits, field mice, squirrels or others. Natural enemies of these rodents are hawks, owls, snakes, skunks, minks, foxes, and other animals. With these predators reduced to the minimum, producers of crops may be faced with the problem of rodent control in the growing of their orchards, small fruit and vegetable plantings.

This injury is generally great enough to warrant the protection of all young fruit and vegetable plants against danger of serious injury. Damage should therefore, be anticipated and guarded against. In fact, the protection of young fruit plantings from injury every fall should be given careful consideration and made a regular orchard practice, just as spraying is done to prevent injury by insect pests and diseases. Also, provision should be made in advance for the prevention of injury to otherfruits and vegetable crops should damage likely occur.

Field, stream and forest rodents do extensive damage to both fruits and vegetables. Some of these also carry diseases such as plague, tularemia, Rocky Mountain spotted fever and relapsing fever that may be transmitted to man. Since squirrels and other rodents may be carriers of disease, handling them or adopting them as pets should be avoided. Valuable information on rodents as carriers of disease may be obtained from the U. S. Public Health Service, Washington, D. C.

It must be stated, however, that a few native rodents may be actually beneficial. Some are neutral as regards to man's interests. For example, muskrats and cottontail rabbits, are considered useful as fur bearers and as game animals for sportsmen and trappers. At the same time, they can be harmful to the farmer and his interests.

CONTROLLING RODENTS

At the outset, it should be understood that there is no easy way of controlling rodents. The general methods consist of the following:

(1) Exclusion or the placing of mechanical protectors and fences around the trees or plants; (2) poison baits; (3) trapping; (4) repellents; (5) shooting; (6) use of poisonous gases; and (7) encouragement of natural enemies.

In determining the method to use, one must know what rodent or rodents are causing the injury. Furthermore, if information is at hand regarding the food preferences and habits for seasonal and year round condition much will usually be gained in establishing effective controls.

FIELD MICE AND THEIR HABITS

In general, field mice do most of their injury to fruit trees and other horticultural plants in the dormant season. Considerably more damage is usually found in apple orchards than in orchards of other fruits. This may be due chiefly to the type of culture that is most commonly practiced in mature or bearing apple orchards.

The so-called meadow or field mice (*Microtus*) are found in most of the states of the Central West. The pine mice (*Pitmus*) also are common throughout the fruit growing areas of the Middle West. Pine mice are second in importance but in some districts and states may do more damage than the meadow mice. Meadow mice feed and live largely above ground and consume seeds and green succulent vegetation, while pine mice live and feed in general below the ground surface where they eat bulbs, bark of roots and stems. There are still other kinds of mice but they are usually non-injurious to trees and small fruits. Control methods will apply equally well to the other kinds as to the ones mentioned.

The meadow mouse has coarse, shaggy fur and may be distinguished by its tail, which is about twice as long as its hind foot if the measurement is taken from the hock to the tip of the toes. It has surface runways and feeds and lives mostly above ground. The pine mouse, on the other hand, has silky-fine, compact, reddish-brown fur. It lives and feeds largely below the surface of the soil. The tail is just about as long as the hind foot.

PROTECTION AGAINST MICE

In mature or bearing orchards, maintained in sod or mulch, the proper use of poison bait is usually the most effective mouse control measure. Young trees, however, which are cultivated and trunk wrapped against injury by rabbits may not need protection by the poison bait treatment. For both young and old orchards much can be accomplished in controlling field mice by clearing away grass, weeds, and litter for a distance of 12 to 18 inches in late summer or fall, from the base of each tree. This is a good practice even though poisoned bait also is used. Mounding the soil from about 3 to 5 inches around the tree trunk in the fall tends to lessen mouse injury, prevent cold damage to the base of tree trunks, and give water drainage away from the trees. In early spring it is well to remove the mounds and level the soil.

During late fall each year an inspection should be made, especially in sod or mulched orchards, to determine whether mice are present. Under the grass or vegetative cover in the orchard, when mice are present, runways on top of the ground will be found. Small openings extending to runways underneath the soil are also present. If freshly used holes and

runways are found, where there is evidence indicating the presence of mice it is time to prepare for poison baiting.

Preparation and Use of Poison Bait.—The suggestions which follow on the preparation and use of poisoned bait for mice are adapted from material supplied by the Division of Predator and Rodent Control, U. S. Department of the Interior, Washington, D. C.

Fig. 32.—A 12-year-old apple tree destroyed by being completely girdled by field mice. (Mo. Agr. Exp. Sta.)

Small ripe apples about $1\frac{1}{2}$ inches in diameter are selected and cut into eight equal pieces. Peeling and coring are not needed. Place 3 to 5 quarts of the cut bait in a clean dry pail or can. Then measure *one level teaspoonful* of zinc phosphide for each quart of cut bait. Dust this poison over the sliced apples and stir or shake until each piece of bait is uniformly covered. One quart of bait will treat about $\frac{1}{3}$ to 1 acre of orchard ground. In preparation and use, prepare fresh bait daily. Use poisoned grain for bait if cull apples are plentiful in the orchard.

APPLICATION.—To place the bait, use a pointed stiff wire or ice pick. Each piece should, for best results, be placed only in surface runways, mole burrows, holes, and under grass and weeds. The ground cover should be examined for runways at about 12-foot intervals. Within the area of runways 3 to 4 placements should be sufficient. One apple slice at each baiting spot is ample. Distribution should cover the orchard, row by row. Thoroughness in the use of the poisoned bait is very important.

TIMING.—Baiting should follow harvest, when cool weather has caused mice to complete their migration. The best time in the Central West ranges from mid-October to late November. In other sections, the period may be a little earlier or later, depending on the occurrence of cool weather. Mice are most active from late forenoon until mid-afternoon. Forenoon baiting, therefore, is preferred. Windy, rainy and cold days are avoided.

PRECAUTION.—Reliable persons only should be entrusted with the preparation of the poison bait. After mixing and at the end of each day, wash thoroughly all utensils in which bait was handled. *Do not handle poisoned bait with bare hands.* The zinc phosphide should be taken from airtight containers. It loses its effectiveness rapidly on exposure. Follow directions carefully.

SOURCES OF ZINC PHOSPHIDE.—This chemical and poisoned grain may be obtained through commercial concerns making a specialty of handling spray chemicals used by orchardists and from the U. S. Fish and Wild Life Service, Experiment Station Annex, Lafayette, Indiana.

GRAIN BAIT FOR MICE

Reliable dealers handle strychnine-treated grain bait. It may be purchased already mixed, and ready for proper use. A heaping teaspoonful of the bait is placed at each bait location, in the surface runways, holes, or mole runways. Those experienced in controlling mice believe that the use of both the grain and apple bait is advisable. This is true because the mice may have a choice of foods. As a result, the fruit grower may profit by destroying more mice through the use of two kinds of poison bait.

VALUE OF WRAPPERS AGAINST FIELD MICE AND RABBITS

Tree trunk wrappers properly placed and maintained give good protection against field mice. If wrappers are used they should extend into the soil to a depth of about 3 to 4 inches and wire wrappers must have meshes small enough to keep the mice out. Wrappers are effective for trees from planting time until they are about 6 to 8 years old. After that they may not need trunk wrappers; but mice are likely to injure the crowns and surface soil roots of both young and old trees in which case poison baits should be used properly.

APPLE ORCHARDS NEED YEARLY INSPECTION

Some mice may do injury to fruit trees, especially apple trees. At all ages of growth, yearly inspections for the prevalence of mice is important.

Mice may do more injury in mature orchards than in young plantings. In bearing orchards maintained in sod or a ground cover of mulch material, the poisoned bait method is suggested if needed. However, the clearing away of litter near the tree trunks and mounding in the fall as stated above may prove helpful in mouse control. Small-mesh wire guards and wraps of various kinds placed down in the ground 3 to 4 inches and properly maintained may also prove effective in mouse control and in addition serve in preventing injury by rabbits.

FIG. 33.—Gunny sack used as a wrap to protect the tree trunk. It may be fastened with a string or thumb tack. The wraps should usually be left on the trunks for 2 to 3 years to prevent injury by rodents, sun-scald and borers. (Mo. Agr. Exp. Sta.)

USE WRAPPERS AGAINST RABBITS

The only safe way to prevent rabbits from gnawing the bark of the trunks of young fruit trees and other woody plants is to wrap the base of the trunks from the ground to a height of about 18 to 20 inches or the space between the ground and the lowest branches. Small plants may be entirely covered by the wraps which are removed in the spring. Where the branches

are less than 18 inches above the soil the wrappers should include both trunk and branches to a height of about 20 to 24 inches. Various kinds of wrapping material may be used. Some of the most common are one-inch mesh poultry wire, galvanized window screen wire, hardware cloth, galvanized wire netting having 3 to 4 meshes to the inch, old newspapers, and gunny sacks torn in strips 6 to 8 inches wide. Wood-veneer wrappers, patented wire wrappers, especially prepared paper and building paper may also be used effectively.

All wraps should extend into the soil about 3 to 4 inches because mice may do most of their damage just below the ground surface. The protectors or wraps should be examined in both fall and spring to determine effectiveness, make adjustments and repairs and to prevent injury to the trunks. Where the ends of cloth or paper wraps in the soil have rotted away, the string ties should be loosened and the soil removed slightly from the base of the tree trunks. The wraps may then be pushed down and the soil replaced. The soil around the base of the trunk is made level after the wraps have been put in place. All litter and trash near tree trunks is removed.

Also Effective Against Borers and Sun-Scald.—Paper, gunny sacks, hardware cloth and wood-veneer wrappers are also good protectors against injury by borers and sun-scald. This is particularly true for apple and pear trees. The wraps may not be entirely effective against the peach tree borer of peach trees but they should reduce borer injury materially. Stone fruit trees (peach, cherry, and plum) are damaged considerably less by rabbits than pome fruit trees (apple, pear and quince). All may need protection, however, when rabbits are numerous and when snow covers the ground.

Wraps May Remain on Trunks.—The various kinds of wraps may remain on the trunks during both winter and summer for two or three years or longer, without doing injury. In fact, the Missouri Agricultural Experiment Station has not found harmful insects or diseases doing serious injury under the wraps on tree trunks. It is true, however, that the exclusion of light tends to cause the bark to become lighter in color. Neither has the removal of wraps during the different seasons of the year and exposure to sunlight and air caused damage.

Furthermore, as pointed out above, there is a distinct advantage to be obtained by leaving the wraps in place for the first two or three years following plantings. This is true because protection against rabbits, field mice and both sun-scald and borer attack is obtained. Trees of all kinds are weakened in the process of transplanting and as a result are much more susceptible to sun-scald and borer attack before becoming well established.

WRAPS AND WRAPPING

Wire Wraps.—The wire used ranges in height from about 18 to 24 inches. It is cut into strips from about 14 to 20 inches wide. The wraps are bent into cylinders, adjusted around the tree trunks and pushed into the soil about 3 to 4 inches by means of a spade or shovel. The laps of wire

are then fastened by pushing cut ends through meshes and bending the ends over, forming loops or hooks.

When the tree trunks are enclosed in the cylinder-shaped protectors, the rims may be a few inches distant from the tree trunk all the way around. Trunk growth expansion may take place, therefore, without making adjustments of the wraps for a few years. Inspections should be made from year to year and after about 5 to 7 years, the wraps may be removed unless there appears to be further need for them.

GUNNY SACKS AS WRAPPERS.—Gunny sack wrappers are usually made by tearing gunny sacks into strips about 6 to 8 inches wide. To wrap the tree begin at the bottom allowing the wrap to fit closely down into the soil 3 to 4 inches and wind the strip spirally around the trunk upward to a height of 18 to 20 inches. One tie at the top with a cloth string is sufficient.

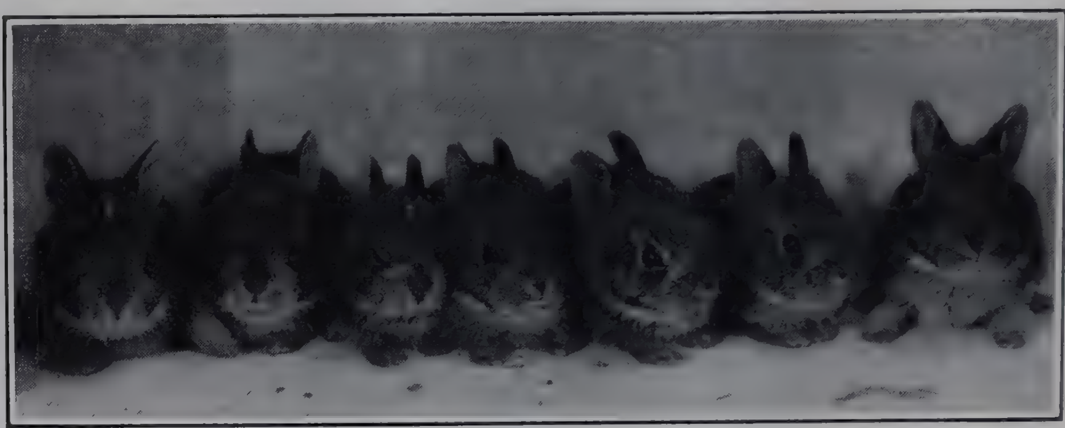

FIG. 34.—Cottontail rabbits (*Lepus floridantus*) one of the most injurious rodents of fruit and vegetable crops. (Mo. Agr. Exp. Sta.)

A better wrap is usually obtained if a little pressure is employed in the wrapping process, making the strips fit closely to the tree trunk. There is no danger of field mice being able to make nests about the tree trunk from the gunny sack material if the strips are wrapped snugly and tied securely at the top and bottom.

NEWSPAPERS AS WRAPPERS.—Old newspapers are frequently used as protectors against rabbits. The paper strips consisting of two thicknesses should be 18 to 24 inches high and about the same number of inches in width. The paper may also be cut into strips as suggested for gunny sack material and wrapped around the trunks and tied in a similar manner. Allow the paper to come down into the soil 3 to 4 inches and wrap it snugly around the tree trunk, causing the paper to fold over and around the tree trunk in a smooth and closely fitting manner. Three ties with cloth string, one at the top, one in the middle, and one at the bottom are sufficient to hold the paper wrap securely. Other kinds of paper are also sometimes used, but tarred paper should not be used as it may do injury to the bark of tree trunks.

WOOD-VENEER WRAPPERS.—Wood-veneer wrappers are bent into a cylinder-shape, placed around the tree trunks and pushed into the soil in

the same manner as the other wraps. Ties are made at the top, in the middle and at the bottom.

REPELLENT WASHES

Not Always Effective.—Avoid repellent washes like blood from a hog or rabbit, whitewash, diluted lime-sulphur solution, home-made and laundry soapsuds, coal tar, gas tar, axle grease, paint, various oils, and similar substances. Some of these materials may damage the plants and none will save the trees when rabbits and mice are numerous and hungry.

Injurious Repellent Washes.—Investigations have shown that such substances as paint, coal tar, gas tar, axle grease, concentrated oils and combinations of such materials may do serious injury to the bark and underlying growing layer of tree trunks and even cause plants to die. A great many factors may be involved in the amount or degree of injury which may be done to the trunks. Most of these substances vary greatly in their chemical composition or makeup. The vigor of the trees or woody plants may cause a difference, and the season or time of application as well as the method of application or the quantity applied may explain the great variations in the severity of damage done to trunks. To be on the safe side, therefore, the grower should not use such substances, as there are others which may be used with equally good results without danger of harm.

Safe Repellent Washes.—If a repellent and poisonous wash is desired, use whitewash, soapsuds or dormant strength lime-sulphur and add lead arsenate at the rate of about 1 pound to 10 gallons. These washes may be applied with a sprayer which facilitates the work. Greater concentrations may be used and the repellent applied by means of an ordinary paint brush. There is little danger of these washes doing injury to the tree trunks, no matter when or how applied.

Poisonous Whitewash.—A thick, heavy whitewash made according to the so-called Government formula has been employed with more or less success on fruit trees to prevent sun scald, attack by rabbits, field mice, and fruit tree borers. The ingredients and methods of preparation are as follows:

Stone lime	$\frac{1}{2}$ bushel	Spanish whiting (plaster of Paris)	$\frac{1}{2}$ lb.
Salt	1 peck	Glue	1 lb.
Ground rice	3 lbs.	Lead arsenate	1 lb.
Water	5 gallons	for each 10 gallons of whitewash	

First slake the lime with warm water and then strain it through a fine sieve or strainer. Dissolve the salt in warm water, boil the rice flour to a thin paste, and dissolve the glue in boiling water. Mix the ingredients in the following order and stir well: Pour the salt solution into the lime, then the rice paste, and next stir in, boiling hot, the Spanish whiting and glue, and finally add 5 gallons of hot water. Stir thoroughly and let it stand for a few days. It should be stirred thoroughly and applied hot with a brush and the trunks of the trees should be kept covered during

both winter and summer. When ready to use, add ½ pound of lead arsenate and stir thoroughly for each 5 gallons.

PRUNED BRANCHES PREVENT INJURY

When the apple trees reach an age of from 8 to 10 years they are not likely to be seriously injured by rabbits. The same holds true with other fruit trees such as peaches, cherries and plums when they attain an age of 5 or 6 years. To minimize the liability of injury, however, the grower should continue to keep the trees wrapped which may grow near fence rows, ravines or other quarters of the rabbit.

For the parts of the bearing orchard located more distant from the haunts frequented by the common cottontail rabbits serious injury may often be prevented by commencing the regular pruning work shortly after the leaves begin to drop in the fall, leaving on the ground near the trees the branches removed. These furnish food for both the rabbits and field mice and they may be fonder of the tender bark on the pruned branches and shoots than that on the tree trunks, which is thicker and tougher. As a result the rabbits and mice do little or no injury to trees 8 or more years old when a sufficient supply of fresh pruned branches may be found on the ground nearby.

SUPPLEMENTARY CONTROL PRACTICES

Encourage Hunters.—During the fall and early winter hunters may be encouraged to destroy the rabbits. They may often lessen the injury to a great extent. Where the work of hunters is very thorough, practically all of the rabbits may be destroyed although they are likely at any time to come into the orchard from distant woodland thickets and other places which furnish food and protection from their natural enemies. Hunters should, however, be warned to guard against starting fires in dead grass and weeds and injuring the trees with gunshot wounds.

Destroy Harbors.—Rabbits may also be largely prevented from doing serious injury to fruit trees by burning or otherwise destroying near orchards, as completely as possible, harbors along fence rows, ravines, in wood lots and rank growing bunch grass on waste land. The destruction of such harbors may prevent depredation by rabbits and mice and at the same time mean much to the fruit grower by enabling him to combat insects and diseases more effectively.

Fencing.—To prevent injury by rabbits, comparatively small plots of trees, brambles, heeled-in nursery stock and vegetables are often enclosed by fences. One-inch mesh poultry wire, screen wire, lattice fence material, board fences and still other materials are used.

A NEW METHOD FOR CONTROLLING ORCHARD MICE

The Michigan Agricultural Experiment Station has recently suggested a new method of control for the meadow mouse (*Microtus pennsylvanicus*,

Ord.) The method consists essentially of the use of zinc-phosphide-poisoned cracked corn distributed by a hand seeder or a gloved hand. It is believed that this practice requires less labor than others. Emphasis is placed upon the distributing of the poisoned bait only in spots protected by a good cover of vegetation. This caution is advised to avoid accidental poisoning of other forms of life and at the same time to make the bait most effective against the mice.

The investigators are of the opinion that the green dye used in coloring the poisoned bait has a tendency to repel birds. However, they recommend that the method of poisoning should be used only in orchards under sod, where the bait should be distributed only in long grass and never on bare soil areas such as roads, paths, and the like. It is also important that no more than the recommended 2 pounds per acre should be used. As is true for other poisoned baits, it is pointed out that the careless use of this new method may result in the poisoning of wildlife as well as poultry, live stock, and pets, or even humans.

The Recommended Formula

Cracked corn	100 pounds
Zinc phosphide	2 pounds
Vegetable oil	1 quart
Methyl green dye	½ ounce

Method of Preparation.—The zinc phosphide and methyl green are mixed together after which the vegetable oil is added. The mixture is then stirred until a smooth thin paste is formed. The grain may be placed on a flat surface, such as a concrete slab, and a hoe used to turn and mix the grain while the oil mixture is poured slowly over the pile of grain. A uniform coating of the grain is essential for the best results. This may be accomplished if the poison is mixed carefully and thoroughly with the grain. Since the zinc phosphide may give off an extremely poisonous gas, the mixing operation should be performed in the open or in a well ventilated building or shed. The gas is very toxic if inhaled. Keep the poisoned grain dry until used, as it deteriorates and loses its effectiveness when moist.

Method of Distributing the Poisoned Bait.—Both the hand seeder and the gloved hand methods have been used successfully. The hand seeder is operated along both sides of the tree rows, thus spreading the poisoned grain under or near the ends of the lower side tree branches. For both methods about average size cracked corn seemed to work best.

The grain may be distributed by gloved hand, using rubberized gloves. The operator spreads the grain along the edge of the mulch beneath the ends of the lower tree branches. An effort should be made to distribute the bait in clumps of tall grass, and in other places where signs of mice may be found. With this method there may be a tendency to use more than the recommended 2 pounds per acre. By dividing the grain into smaller quantities, each to be used in a part of the orchard where it may be most effective, there may be less danger of poisoning wildlife and at the same time the bait may be effective against the mice.

CONTROLLING OTHER RODENTS

There are many other rodents that may, particularly, at certain seasons of the year, damage fruit and vegetable crops. Some of these are the ground squirrels of the various types, the common so-called forest squirrels, the woodchuck, pocket gopher, and still others. For nearly all of these the poisoned grains and poisoned baits of fruits, vegetables, etc., suggested for other rodents may be effective if used properly. Some adjustments naturally will be required based chiefly upon the life histories and food habits of the particular species. Furthermore, trapping, shooting, destruction of harbors and natural food, the erection of barriers or fences and the employment of other methods as supplementary controls may be needed in some instances.

TREATMENT OF INJURED TREES

Where rabbits or field mice have gnawed the bark of the tree trunks practically all the way around but have not peeled it to the wood except in spots here and there, bridge grafting as a rule is not needed. An application of grafting wax or even para-wax applied thoroughly to the damaged areas, will generally prevent drying and assist in healing the wounds.

If the injury occurs in winter the wounds should be protected by a coat of grafting wax preferably to prevent drying of injured tissues. If bridge grafting is required it should be done in the spring as soon as the bark will peel freely. During the growing season, if grafting is needed, the operation should be performed as soon after the injuries as possible.

DAMAGED OR WEAK TREES

For full information regarding treatment by Cutting Back Damaged or Weak Trees consult Chapter 6, page 74, under the heading given. This is important, because the suggestions made may be helpful in caring for trees injured by rodents.

VEGETABLE CROPS AND RODENT DAMAGE

Rabbits, woodchucks, squirrels of various types, field mice and still other rodents frequently damage growing vegetables in both rural and suburban areas. Where the procedure is economical, fencing is suggested for control and prevention of damage by most rodents except the common red squirrel. Dusting the plants with sulphur or spraying with nicotine sulphate is believed by some growers to be effective as a repellent in preventing injury to vegetable crops.

Woodchucks.—These pests should be eliminated in late winter or early spring before vegetation hides the openings of the dens used by the rodents. Perhaps the latest and most effective means of control consists of the proper

use of the woodchuck "bombs." The County Agent may be able to secure this material for the use of gardeners and fruit growers at cost by making a request to the U. S. Fish and Wild Life Service Experiment Station Annex, Lafayette, Indiana.

The poisoning methods suggested for other rodents has in general, especially in the Western States and in the East been successful. However, extermination campaigns on a large scale have generally been conducted through the use of gas "bombs" in the burrows of the woodchucks.

CONTROL OF SQUIRRELS OF VARIOUS TYPES

Poisoning.—Strychnine-coated barley or other grains similarly treated is used in the season when squirrels are gathering seeds and grains for storage. The poisoned grain is scattered by hand, a tablespoonful at a time, placed on hard bare ground, along squirrel runways, fence rows and elsewhere. One quart of poisoned grain should provide enough for 30 to 35 baits. Care should be taken to prevent farm animals including poultry from eating poisoned grain. Song birds and others are not likely to eat the bait.

CONTROL OF POCKET GOPHERS

Trapping is especially useful in gardens, orchards, small fruit plots and on the banks of ponds and irrigation ditches. Perhaps as much or more gopher control is accomplished through the use of traps as by any other single method.

Poisoned baits are also used effectively against gophers. Strychnine alkaloid or sulphate is satisfactory for this purpose. Cubed root vegetables are in general use but grains either hulled or crushed, dried fruits and still other plant products may serve effectively. For the best all-around results, baits are placed in the main runways by means of a rod or stick used as a probe.

Moles and Mice.—Moles are frequently blamed for damaging gardens. However, the chief food of moles consist of adult insects, grubs and worms. Mice often live and feed in old mole burrows, doing considerable damage to crops and the mole may get the blame for this. Methods of poisoning mice and suggestions for controlling rabbits that may also destroy vegetables have been given under preventing damage to young fruit trees in this chapter.

Chapter 14

Windbreaks and Cold Injury

Although there has been much discussion among both producers and experiment station workers regarding windbreaks and shelterbelts, there is comparatively little exact information available on the subject. All are in accord, however, as to the great variations in local conditions of exposure, the character and frequency of prevailing winds, and topography of the land planted to horticultural crops.

Windbreaks and Shelterbelts.—Both windbreaks and shelterbelts are used in protecting horticultural crops from damage. The shelterbelt differs from the windbreak in that the area covered by the planting may be considerably wider than the windbreak. The more extensive shelterbelts may consist of comparatively narrow strip plantings or single rows of trees designed to protect plantings of fruits and vegetables. The windbreaks are shorter and consist of less extensive plantings than shelterbelts. Such plantings of shrubs, trees or both have generally reduced yields of fruits, vegetables and field crops that grow near. The roots of the windbreak excepting the Multiflora Rose take from the soil moisture and nutrients that otherwise might be used by the cultivated crops. The shade produced by the shelterbelt or windbreak may also reduce growth and production of crops that grow nearby.

In general, the shelterbelts of broad-leaved trees do more damage to adjoining crops than the narrow windbreaks but the shelterbelts produce more wood in proportion to the amount of land used. All types of windbreaks should be at least 30 to 40 feet from the first row of trees or small fruits with one exception. Where the Multiflora Rose is used as a low windbreak, fruit crops may be planted as close as convenient for handling. This is due to the tendency of the rose to root rather deeply and in a comparatively narrow zone. As a result, crops may thrive within a few feet of the barrier or windbreak. In the shelterbelt, comparatively close planting may cause the trees to grow straight and have long bare trunks with but few knots while in the narrow planting the trees may tend to produce short and stubby types of growth.

TYPES OF WIND INJURY

Damage From Desiccation.—Perhaps one of the most important types of wind injury to fruits and vegetables consists of the drying out of the

plant tissues. Such desiccation or drying makes both tree and small fruits more susceptible to damage by winter cold and summer drought.

It is believed that the windbreak should be planted as much for the protection against the hot drying winds of summer as for protection from the cold drying winds of winter. Shelters may be particularly valuable to fruit crops under these conditions to prevent excessive drying out of woody tissues. The Great Plains region may offer typical examples of damage. Shelterbelts 7 or 8 feet high in this plains country if established before planting crops should help materially with the growing problems.

Wind Velocity Effect.—Investigations have shown that a wind velocity of 30 miles per hour will evaporate 6.3 times as much water as a calm atmosphere of the same temperature and humidity. Furthermore, observations indicate that a wind movement in the open may reach a velocity of about 25 miles per hour while in the shelter of a good windbreak the velocity may not exceed 5 miles per hour.

Local Influence.—In this connection, it should be understood that, in general, a windbreak 25 to 40 feet high has its most marked influence in the leeward area about 10 to 15 rods wide. Also, on a quiet frosty night a windbreak on the side of the orchard from which there is an air movement may increase the likelihood of frost damage. This is due to an accumulation of cold air in the shelterbelt area and the loss of heat by radiation. On the other hand, where orchard areas are heated on frosty nights, the windbreak may be helpful in slowing down the movement of unheated air into the orchard.

Summary of Benefits.—The windbreak reduces evaporation and may lessen the effects of drought in summer and cold injury in winter. It helps to retain snow and leaves on the ground and prevent deep soil freezing and excessive evaporation. Sandy soils may be held and prevented from drifting. In some locations, there may be less breakage of tree branches and the dropping of fruits.

The windbreak or shelterbelt may protect in the plains area and elsewhere, the fruit and vegetable garden at all seasons of the year. In many instances, it is considered almost useless to attempt the growing of these crops without such shelters. All growing crops may be subjected in some sections to serious damage or destruction by soil drifting, blow-down, firing by hot winds, loss of soil moisture, or injury by frost and sleet. Tree crops such as apples, peaches, cherries, plums and citrus fruits may be benefitted greatly by protecting the trees during the pollination or blooming period. Wind damage to both the green and ripening fruits may be lessened or prevented.

It is well known that fruit may not set on the windward side of trees when windy conditions prevail at the blossoming periods. This may be due to the fact that the honeybees are unable to work the bloom on the sides of the trees exposed to the winds. By reducing wind velocity more favorable conditions for pollination by bees may be established.

It is also true that fruit trees in protected areas with lower wind velocity are easier to spray properly. The orchard trees do not develop as much lean or become as lopsided as trees in exposed situations.

MULTIFLORA ROSE FOR WINDBREAK

Mention has been made in reference to the value of the Multiflora Rose hedge fence as a windbreak. From observations and tests made to date, the use of this barrier as a low windbreak is fully justified. Anywhere in the United States where the plant may be grown successfully it is believed to be well worthy of a test as a low windbreak. The great value of the Multiflora Rose as a fence or enclosure has been tested and demonstrated in nearly all sections of the United States.

FIG. 35.—Several different kinds of pines being used effectively as orchard windbreaks (Mo. Agr. Exp. Sta.)

EVERGREEN WINDBREAKS

In many parts of the United States and particularly in the open or prairie regions, evergreens are often considered best as windbreaks. The trees hold their leaves or needles throughout the year and grow thick clusters of branches from the ground to the tree tops. Also, the evergreen trees are generally of much longer life than the broad-leaved or hardwood trees. Species which have proved successful as windbreaks follow: Scotch pine, jack pine, ponderosa pine, short leaf pine, Rocky Mountain red cedar, Austrian pine, Virginian pine, and Colorado blue spruce.

Where rainfall is sufficient, the cone-bearing trees, such as pines, hemlocks and spruces may be more suitable for planting. However, they may not be so satisfactory without irrigation in the dry seasons of much of the western prairie region. Irrigation may be particularly needed following

transplanting and in getting the trees established. Wherever possible final selection of trees and shrubs should be those that have been tested in the section and found serviceable. Whether a shelterbelt or a windbreak, the grower should make his decision after a full consideration of his needs.

HARDWOOD WINDBREAKS

Shelterbelt and windbreak trees should be selected that are suited to the region or district concerned. Various kinds or species have been used with varying degrees of success. Some of these are the Russian olive, osage orange, cotton wood, American elm, honey locust, Chinese elm, green ash, hackberry, white and golden willow, boxelder, and chokecherry.

SOIL PREPARATION OF PLANTING SITE

The site or area where the evergreens are to be planted should be pared in a manner comparable to a field fitted for planting to corn or wheat. As every good farmer knows, plowing as deeply as conditions permit followed by disking or harrowing is required for a proper seed bed. The strip of land upon which the evergreen or hardwood trees are planted for a windbreak should have equal care and attention in preparation for planting to the trees.

When to Plant.—Toward the North planting in the early spring as soon as soil and weather conditions permit generally gives the best results. In the more southern areas or south of the southern borders of Missouri, Illinois and Kansas, late fall or early winter planting may prove preferable.

THE PLANTING OF THE TREES

In planting, the roots should not be exposed to the sun and wind even for a few minutes. The most favorable planting times are during cool, humid, cloudy weather. The conditions will also be more satisfactory if an ample supply of moisture is in the soil.

The tree holes should be deep and wide enough to accommodate the root systems of the trees. When the planting is finished the trees should stand about $1\frac{1}{2}$ to 2 inches deeper than they stood in the soil before digging. After the tree is placed in the hole the roots are distributed and straightened out. Top soil is then placed on the roots and allowed to sift down among them. More is added and firming the soil by tramping is begun. This is continued until the hole is about half or two-thirds full. Then if water is available it is used in filling the hole. After the water is absorbed by the soil, finish filling the hole and omit the tramping or firming of the soil. Where water is not available, continue the filling with soil until it is level with the surface after which let the last one or two shovels full lie loose.

CARE OF TREES AFTER PLANTING

The first year after transplanting is the crucial one for all the plants and particularly for the young evergreens. In dry periods especially during

July and August in some districts, irrigation at intervals of 10 days or 2 weeks followed by cultivation when the soil is workable may be needed to procure a good stand of trees. Where a mulch of straw or other litter is used of sufficient depth to keep down vegetation, cultivation is not required but irrigation may help materially in saving the trees while they are becoming established.

Mulching is generally preferred to clean cultivation in starting the windbreak trees. Where the practice is adopted, it should be applied soon after planting. The mulch may consist of clean wheat straw, haystack butts, pine needles, slew grass or other litter. It is applied at a depth of about 3 to 5 inches or in sufficient quantities to keep down grass and weeds.

FIG. 36.—Close-up view of five-year-old Multiflora Rose fence in summer condition showing both a dense green barrier and effective low windbreak. See Chapter 3 for cultural practices. (Mo. Agr. Exp. Sta.)

In some sections it may be advisable to renew the mulch at intervals of about every second to third year. The mulch is likely to be found a great conserver of soil moisture and it prevents water and wind soil erosion. Perhaps the only serious drawback is that the mulch does create a serious fire hazard. To prevent damage from fire, therefore, it may in some instances especially be wise and worthwhile to establish fire guards by plowing, cultivating or otherwise destroying vegetation in a strip 20 or more feet wide in the area fairly near the planting.

Cultivation between the rows of trees where mulches are not available or too expensive for use may prove very satisfactory. It may be needed for several years after planting. Tree losses should be replaced the next planting season. Where mistakes or omissions were made in handling the project the first year, and opportunity for their correction and the adoption of better culture the following year and in the future will be afforded.

Livestock and poultry should not be allowed in the windbreak areas. The mulch on the soil and the litter that is blown into the planting may create a fire hazard. To prevent losses that would follow destruction by fire, the preparation and maintenance of fire guards of sufficient width and effectiveness as suggested, for seasons of the year when fires are likely to occur, is important.

Still another serious enemy of windbreaks is livestock. The damage caused may be as sure as fire in destroying eventually the shelter of tree growth. Browsing of the lower branches may open up the stand to the drying action of winds. Snow blows through and available moisture is lost. Tramping compacts the soil and smaller portions of moisture from rain and snow reach the tree roots.

COLD INJURY

Fruit trees, grapes and small fruits are subject to injury by cold in all of the growing sections of the United States. The degree of severity of damage may vary markedly in the different states and districts. Cold injury of autumn, winter, or spring that damages or kills plant tissues or destroys the entire plant may become an important problem of the fruit grower in every section of the country.

The earliest authentic records of the U. S. Weather Bureau show that cold winters of considerably more severity than the average have occurred at fairly regular periods for about 170 years. Furthermore, these so-called "test winters" or winters of abnormally low temperatures have occurred in cycles of about one exceedingly cold winter for every 8 to 9 years. Additional studies indicate that there is no evidence to warrant the assumption that the winters are becoming colder or warmer. The occurrence of cold winters applies chiefly to conditions toward the North. In the South, injury is most often due to the occurrence of abnormally warm periods followed by moderately cold weather conditions.

HOW FREEZING KILLS

Thus far, no one has been able to determine definitely how freezing kills. Several explanations or theories persist and the best of these are not clear or conclusive. Most investigators agree, however, that death to plant tissues seems to be due to the actual withdrawal of water from the cells and tissues to form ice particles. The formation of ice tends to dry out the cells and the plant may suffer from drought conditions. Furthermore, some believe that when the ice masses in the protoplasm thaw, the protoplasm itself may become disorganized and killed through the formation of chemical substances as a part of the oxidizing action. Another explanation would account for the destruction of cells and tissues by water moving out of the cells and freezing between the cell walls and in the intercellular spaces causing an excessive strain and injury to the protoplasmic layer. Such damage may be due to the rapid and possibly uneven contraction of the affected parts.

HARDINESS OF FRUIT TREE TISSUES

Starting with the outside of the fruit tree trunk or bark, we observe the *epidermis* or outer dead bark; then the *cortex* which replaces the epidermis and commonly known as the bark is found; next in order is the *phloem* or inner live bark, which serves as the conductive tissue that conveys the elaborated food materials from the leaves down the stem; the *cambium* is next consisting of a thin layer of active cells between the live bark and wood. The *xylem* or sapwood follows the cambium and conveys water from the roots up the stem and supplies mechanical support; and finally the *pith* tissues in the center make up the central portion. These parts vary in hardiness and their resistence to cold may change at different seasons of the year. (*See* Fig. 4, page 21.)

Stems and Branches.—With the full maturity of the trunk, branches and twigs, the pith is the first to be killed by cold, after which the sapwood may develop a brownish color as well as the outer or old cells of the phloem or inner bark. On the other hand, it is interesting and essential to know that the cambium, the thin tissue of cells between the inner bark and sapwood is most tender to cold in the growing plant but comparatively hardy in winter when trees are dormant.

Roots.—The cambium of the fruit tree roots is likely to be the first tissue to be killed by cold. The sapwood will usually show the next most serious injury and the damage may continue into the phloem (inner bark) and then to the cortex (outer bark). The mature xylem and pith toward the center of the root may be relatively free from damage unless very cold temperatures are experienced.

SOME CONTRIBUTING FACTORS TO COLD DAMAGE

The drying effect of wind and also the effect of cold winds on the temperature of exposed tissues is important. Winter injury is sometimes more severe in the three or four rows nearest the windward side of the orchard.

Consideration should be given to the unequal maturing of tissues on different sides of the tree trunk. Observations have shown that maturity may be attained more rapidly on one side of the stem than on another.

To the unaided eye both wood and bark tissue may appear entirely brown when with the aid of a microscope it may be found that many cells are alive. It is also true that the microscope may reveal dead cells that to the unaided eye appeared to be uninjured.

When the wood is well matured the cambium as previously stated is one of the most resistant of tissues to cold damage. On the other hand, when the cambium is active in growth it may be killed when the injury to the bark and sapwood is not great. However, when trees have gone into the winter with all tissues well matured, the inner bark seems to be more resistant to cold than the sapwood. It has been observed that many fruit buds of Jonathan have been killed where the trees were growing on poor land or in sod and were probably in an advanced stage of differentiation or change from leaf to fruit buds.

INFLUENCE OF TEMPERATURE CHANGES.—Investigations supplemented by extensive orchard observations have shown quite clearly that the rate of temperature fall is very important, especially in the case of winter buds. The duration of the low temperature is another factor to consider. Contrary to the general opinion, however, there is little evidence to support the claim that rapid thawing of plant tissues is more injurious than slow thawing.

With a rapid drop in temperature the grower may anticipate, therefore, more damage frem cold. Furthermore, if the cold period lasts or continues for a week or more instead of a day or two the damage to fruit trees is likely to be greater. The rapidity with which the tree tissues thaw out is not considered of great importance. Naturally, however, gradual or slow thawing may have more or less minor advantages.

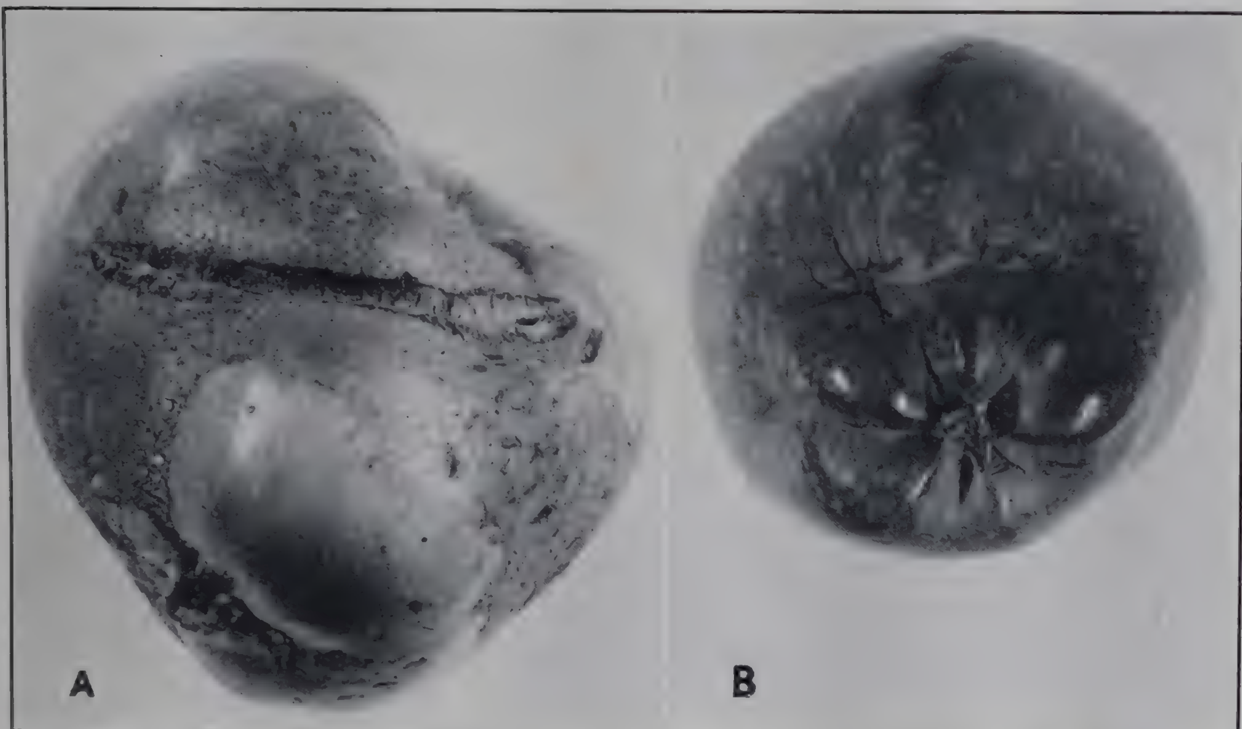

FIG. 37.—A, apple showing cold injury that occurred soon after fruit set. B, apple drought damage produced about 6 weeks before harvest. (Mo. Agr. Exp. Sta.)

REST PERIOD AND DORMANCY

It has been well established by Whitten and Howard of the Missouri Agricultural Experiment Station that perhaps all plants have a definite rest period. This so-called "rest period" may be defined as the period or time during which fruit trees will not grow even when conditions are favorable for growing.

CHILLING EFFECT NEEDED.—After leaf drop, if chilling temperatures of about 35° to 40° F. have occurred the rest period may be over for most kinds of fruit trees and somewhat later all the buds may have emerged from the rest and are ready to grow. The rest is broken earlier if temperatures of about 40° F. or lower have been experienced in the orchard. In mild climates, however, where the temperatures throughout the winter

remain constantly at about 68° F. or higher nearly all the buds may continue in the rest period and fail to grow in early spring. Under such conditions some buds may open long before others and large numbers may not develop leaves, flowers or shoots. It is obvious, therefore, that the rest period and a lack of sufficient chilling periods to break it may become serious problems in fruit production for sections where mild and equitable climates prevail.

Dormancy.—For the sake of clarity the student and grower should distinguish between rest period and dormancy or the dormant condition. As previously stated the rest period is designated as the period when the plant will not grow, even though temperature and moisture conditions may be favorable. Furthermore, the rest may begin in late July or early August when the trees are in leaf and developing crops of fruit. In contrast, the term "dormant" is used to indicate a lack of activity from any cause. Furthermore, it refers to the period when the tree is without leaves and noticeable indications of growth activity.

To illustrate, an apple tree may be dormant in February because the temperature is too low for growth. The same tree may have been dormant in December due to cold temperatures and at the same time under the influence of the rest period. Where the winters are long, therefore, fruit trees may remain dormant long after their rest periods have ended.

KINDS OF WINTER INJURY

Winter cold injuries may be grouped into the following classes: (1) bud injury; (2) injury of the woody parts above ground; and (3) root damage.

Bud Injury.—If for any reason buds go into the winter in an immature condition and low temperatures occur fairly early (November or December) different degrees of damage depending upon the severity of the cold is possible. Exceedingly low or severe temperatures even in mid-winter or at any period during the dormant season may kill the tissues and buds of woody plants. Still another cause of injury may be due to the occurrence of unseasonably warm weather in late winter or early spring followed by temperatures low enough to cause damage. The most tender parts of the flower buds are the pistils. These may be killed and the set of fruit destroyed without material harm being done to other flower parts.

The flower buds of the apple and pear are rarely killed by winter temperatures. Sour cherries, like apples and pears, are hardy in bud. In some fruit sections, however, particularly toward the north the buds of the Japanese and European plums may be injured as they are likely to be very little if any hardier than peaches. Sweet cherry buds are generally about as susceptible to cold injury as peach buds which are the most tender of any of the deciduous tree fruits. The fruit buds of varieties of peaches vary greatly as to resistance to cold injury. Consequently no definite or exact winter temperature can be given, although temperatures of −18° to −20° F. is apt to destroy nearly all the peach flower buds whether in or out of the rest period. In fact, temperatures of −12° to −15° F. may be sufficient to wipe out all the peach fruit buds and the prospects for a set of

fruit. Furthermore, even $-10°$ F. may thin the buds too much for profitable fruit setting.

In general, the commercial varieties of grapes of the *Vitis labrusca*, *vulpina* or (*V. riparia*) types are comparatively resistant to winter cold. On the other hand, the varieties or kinds related to the *vinifera* (Old World grape) may be quite tender in both bud and wood. Such varieties as Concord, Moore Early, Worden, Fredonia and Caco are ranked as hardy. The Golden Muscat, Niagara, Wilder, Agawam and Duchess are considered tender to cold.

Dangerous Temperatures for Fruits—Degrees Fahrenheit
(After West and Edlefsen, Utah Agr. Exp. Sta. Bull. 151, 1917, with rearrangements)

Fruits	*Buds Closed but Showing Color*	*In Full Bloom*	*Setting Fruit*
Apples	25 to 27	28 to 29	28 to 30
Peaches	20 to 29	25 to 30	27 to 30
Cherries	22 to 29	28 to 30	28 to 30
Pears	25 to 29	28 to 29	28 to 30
Plums	22 to 30	27 to 31	28 to 31
Apricots	22 to 30	29 to 31	30 to 31
Prunes	28 to 30	29 to 31	30 to 31
Almonds	26	27	30
Grapes	30	31	31

KINDS OF DAMAGE DONE BY COLD

Bark and Trunk Splitting.—In some sections, trunk bark splitting and even cracking of trunk wood occurs after severe winter weather. Trunk splitting, however, is much more common with shade and forest trees than for fruit trees. When bark splitting occurs, repair treatment is in order as soon as weather conditions permit and after thawing of bark tissues. It consists of pressing the bark snugly and smoothly against the trunk and fitting the edges together carefully. The bark may then be tacked down and held in place through the use of a few short broad-headed shingle nails. Upon the arrival of conditions favorable to growth, development and healing of the wounds may occur in a normal manner. To prevent drying, grafting wax may be used in the repair work to cover wounds and cracks and crevices in the bark.

Crotch and Trunk Base Injury.—This is a common type of injury and occurs in the crotches or forks of both large and small branches. It is most often found at the base of the large limbs or scaffold branches or in the angles or crotches where they join the tree trunk. The bottom or base of the tree trunk may be injured just as often and as severely as the tissues in the forks or crotches of the lower branches. As these areas of the tree trunk are the last to mature in the fall and early winter they are usually most likely to be damaged by cold. If very cold weather occurs early in winter such injury may be serious.

Sun-scald.—This type of injury is due to the frequent warming-up and freezing of the tree tissues particularly on the southwest side of the

trunk. Such alternate freezing and thawing may occur day after day during the winter. With the growing layers next to the trunk damaged, a favorable area on the trunk is made for the attack of borers.

This damage may be prevented by setting in the soil on the exposed southwest side near the trunks of young trees and older ones, that do not have low branches to shade the trunks, boards or barrel staves for shade. Whitewashing and wrapping the tree trunks in the fall as other methods may be used to prevent sun-scald injury.

Contributing Causes to Cold Injury.—Orchard trees which have been neglected and weakened are notoriously susceptible to cold damage. This is true for trees defoliated by insects or diseases, one or both. In heavy crop years, trees that have not been fruit thinned may be lacking in vigor and devitalized. Such trees may be made more susceptible to winter cold injury. The lack of proper fertilization to keep up tree vigor and fruitfulness may also gradually weaken trees and prevent them from developing hardiness. Likewise, attacks by scale and borers may prove to be contributing causes of cold injury.

HOW TO PREVENT WINTER COLD DAMAGE

Maturity of Tree Tissues.—Perhaps, of all the cultural methods or measures that growers may adopt and use, the securing of full tree maturity as nearly as possible in the fall is the chief goal. Pruning, cultivation, fertilization and irrigation practices that may stimulate vegetative activity should, in general, be planned to promote spring and early summer growth. Likewise, these practices for the periods of late summer, fall and early winter should be discontinued in order to inhibit or slow up growth and thus promote tree maturity.

It should be clearly understood that the practices that stimulate growth such as cultivation, fertilization, irrigation and even pruning should be so regulated through study and observation of the trees, that growth activities are stimulated early in the spring and slowed down in mid-summer and early fall. It is important to know that the ommission or withholding of the practices listed tends to cut down or lessen growth. Furthermore, stopping cultivation in early summer and allowing grass and weeds to grow or sowing cover crops may prove helpful. This is true because the growth of the ground cover may take moisture and nutrients from the soil that might otherwise be used by the trees. The result may be a gradual slackening of tree growth and a chance for the development of hardiness.

Trees that grow on soils that are not well drained and that may be termed slightly wet or "seepy" may promote late fall or early winter growth and the likelihood of winter cold injury. Heavy fertilization with commercial nitrogen fertilizers or manure for a series of years may have a tendency to keep trees too vegetative for good fall or early winter maturity that may withstand winter cold. This may be particularly true if slowly available commercial nitrogen fertilizers are used in the spring. Manure applied in late winter or spring may cause trees to continue growth too late for proper maturity.

It has long been known that both heavy and light pruning of the tops of mature trees may be an invigorating process. In general, the heavier the cutting, the greater the length growth. To retard growth, therefore, less pruning should be done and usually it may be performed to the best advantage during the dormant season.

ORCHARD HEATING AND SMUDGING

HEATING.—The Agricultural Experiment Station workers are agreed generally throughout the United States that the heating of apple, pear, peach, plum and cherry orchards, including grape and small fruit plantings at blossoming time to prevent frost damage, rarely pays. When killing frosts occur, the temperature may drop too low to be modified or changed materially through the use of the most modern orchard heating equipment and the employment of the best heating practices. Even under the best condition for orchard heating, it may not be possible to raise the air temperatures at the level of the tree tops more than 2 to 3° F. Generally, this is not enough to prevent cold damage.

Furthermore, periods of 6 to 7 years or more may elapse in many fruit growing sections without needing the use of heaters. Under such conditions, the cost of maintenance may be considerable. If these costs are added to the other orchard handling expenses, rarely if ever can they be justified by extra returns from orchard heating practices.

SMUDGING.—The building of smoke fires in and about fruit plantings, when frost damage threatens in early spring at the blooming periods of fruits, has been long considered of value by some growers. However, careful experiments and observations have repeatedly failed to confirm such beliefs. Only the heat released from well distributed heaters or fires over the orchard is likely to be of value in saving a fruit crop. It is well known that the smoke or smudge that arises from smoldering fires in and about the orchard have little or no effect on actually raising the air temperature at the height of tree tops.

ORCHARD HEATING PROBLEMS.—Even with citrus orchards it is known that under the most ideal conditions, only limited protection from frost damage may be afforded by orchard heaters. When preparing to prevent frost damage by orchard heating, some important problems are worthy of careful consideration. Some of these are the cost of heaters required including fuel, expense for labor in firing and maintaining, frequency of need, authentic results from heating practices in the district under comparable conditions and the final price to be received for the fruit. These problems are of importance to the growers of fruits when considering the possibilities of orchard heating.

In citrus regions, sometimes a range of from 2 to 3° F. may mean the difference between injury and no injury. Also, the currents or movements of air that may interfere with orchard heating are likely to be less prevalent in citrus districts than in deciduous orchards when orchard heating may be needed. Furthermore, there is some evidence from investigations indicating that citrus growers with good management in certain locations may be able to use successfully orchard heating equipment.

Chapter 15

The Home Fruit Garden

No one can actually measure the true value of a home fruit garden or planting from a dollar-and-cents point of view. The satisfaction coming from the use of fresh, crisp, wholesome fruits of the desired varieties alone may go a long way toward justifying its establishment and maintenance. Investigators have shown, also, that a majority of farmers and suburban property owners who depend upon timely purchase of fruit to meet the needs of the home rarely supply their families with adequate quantities of fruit in season.

A home fruit garden may assure a supply of fresh edible fruit from spring until late fall. Such a food supply, besides helping materially to reduce the living expenses throughout the entire year, contributes greatly to the family's health and happiness. Most persons living in the country, as well as those in towns and cities where there is a space which may be devoted to the growing of fruit plants, will agree that a good fruit planting is desirable and an asset to the farm or suburban property.

SOME VALUES OF A FRUIT GARDEN

Fruits come to the consumer in their true, complete, natural state, wrapped in Nature's protective covering. They cannot be adulterated and they do not require the addition of enriching elements such as is necessary in some other foods. Their vitamin content is well balanced and varied. Their minerals and other characteristics supply easily digested foods for energy but in a nonfattening form. Apples are particularly fine for bones and teeth and act as Nature's toothbrush. The protective qualities of apples and other fruits are truly remarkable; they act as a gentle, mild laxative that keeps the intestinal tract in good condition. Apples also are used by medical authorities for treatment of summer complaint of children. No other food has such a wide and diverse combination of excellent characteristics—of equal value in both youth and old age.

In general, fruits are good sources of vitamins. Many rank high particularly in Vitamin C. For example, strawberries rank above citrus fruits in this respect. The yellow-fleshed fruits including yellow peaches are excellent sources of Vitamin A. It is well known that the sweet fruits are prized highly for their sugar content. Fruits, therefore, should not be regarded as relishes but as staple and dependable articles of food. Furthermore, a home fruit garden if planned carefully, will confine the plantings to the kinds and varieties that are actually needed. With such a purpose

constantly in mind, the producer is more than likely to find the fruit garden an economical source of highly prized wholesome fruits.

HOME FRUIT GARDENS PAY

Many may think that the fruit planting will require an undue amount of work. This is not true for one acre or less in extent. In fact, the care amounts to so little that no one, if his work is properly managed, should be handicapped or delayed in handling other enterprises.

It is of paramount importance that the producer keep in mind the main or true object of the home fruit garden; namely, to supply enough fruit for the family. Too often more tree and small fruits are planted than are needed for this purpose, and as a result the work of caring for the trees and plants is neglected and the fruit project may become a mediocre success.

Results from investigations at the Missouri Agricultural Experiment Station and others indicate very forcefully that the average person should not maintain a home orchard of more than an acre, while a planting of one-half acre or less is likely to prove more profitable. With proper care and attention the area is likely to pay well for the time and effort employed. The returns to the yearly food supply of the family and the genuine enthusiasm and satisfaction derived from the home fruit garden are likely to prove tremendously worthwhile.

IT IS POSSIBLE TO HAVE THE BEST

In the fruit garden it is possible to grow varieties and kinds that cannot be purchased on the average market. Commercial fruit varieties must usually meet certain requirements such as ability to withstand packing and shipping practices. Varieties and kinds for home uses may not necessarily be required to meet the standards and regulations applied to commercial sorts.

Consequently fruits of higher flavors, better texture and superior aromas may be enjoyed from the fruit garden. The plot of ground may be devoted almost entirely to growing the fruits most sought and most difficult to secure. It may matter little whether they are the best for local or commercial markets because they are being grown chiefly for the enjoyment and uses of the family.

A succession of fruits may be harvested. They may range from those that ripen early in the spring to others that may mature late in the fall or early winter. Abundant supplies for fresh consumption, daily uses for pies, salads, sauces, jellies, preserves and the like are possible from spring until late fall. Generous quantities should also be available to store for winter use in the fresh state and as canned, frozen and preserved fruits. Furthermore, tree and vine fully ripened fruits that reach their most delicious flavors and aromas may be had.

PLANT FRUITS AND VEGETABLES TOGETHER

Those who plant vegetable gardens can just as well be growing a small home orchard or fruit planting. The fruit planting will make as valuable

a return for the average family as does the vegetable garden itself. The cultivation and fertilization given the vegetables is just what is required for best growth and development of the young trees and other fruit plants.

PLANNING THE FRUIT GARDEN

When planning to grow fruit for home uses, reliable information should be secured in the beginning regarding the selection of a suitable site and accessible location. The kinds and varieties of fruits best adapted to the locality and to the needs of the producer constitute the most important decisions of the grower. These problems should be solved and answered before the trees and plants are ordered.

Also, the fruit planting plan should be included in the scheme for planting the family vegetable garden because it is generally advisable to grow the crops in the same area for at least the first few years. Since small fruits such as strawberries, raspberries, blackberries, and others may be planted as inter-crops, they too should be considered in the development of the planting arrangements, and procedures. It is usually wise and profitable to start a new fruit planting as soon as each fruit has reached or passed its most productive stage. The fruit garden for best results, therefore becomes a rotating enterprise instead of a stationary planting and this information should be noted at the outset.

The most serviceable fruit gardens contain several different kinds of fruit, represented by a number of varieties, ripening one after another from spring until late fall. The home fruit growers may be interested most in high dessert quality, consumption of the fresh tree and cane ripened fruits, and their special excellence for cooking purposes. In contrast, the commercial grower is likely to demand large yields, picking when hard ripe, good shipping quality and attractiveness in appearance.

SELECTING THE LOCATION AND SITE

The location usually has to do with accessibility or ability to reach the fruit garden. Its proximity to roads, walks, public grounds and the like is important. On the other hand, the site is given consideration because it refers to elevation, air drainage, slope, character of land, influence of bodies of water, buildings, etc. The nearness of the fruit garden to the house and other structures about the home grounds may be more important than superior site and soil advantages.

Nearly all the fruits can be grown on a wide range of soil types, however it is well to avoid if possible very light sandy or coarse gravelly top soils and subsoils. These may be too porous and aerated for the plant roots to withstand drought conditions particularly in mid-summer. Heavy clay soils and subsoils which are characterized by having almost impervious subsoil or hardpan are not an improvement. Adequate soil drainage, and aeration are very important for all fruits. Even more difficult for a satisfactory growth of fruit plants is surface soils underlaid with rock at depths ranging from a few inches to 2 or 3 feet. Unfortunately there is not much we can do about this.

Cold air tends to settle to the lowest levels. With the site surrounded by higher elevations and without good air drainage to lower levels, the fruit blossoms are more likely to be damaged by untimely spring frosts. The higher ground may furnish better air drainage, yet this is not always true. Comparatively level and broad areas may be satisfactory for the movement of cold air masses.

One desirous of a home fruit garden, however, should not be discouraged or disturbed too much for lack of having ideal soil, location and site. In fact the plot that meets every requirement is seldom obtainable. Much can be done and accomplished through the adoption of good soil handling and growing practices. Clay soils needing better aerations and drainage can be improved markedly by incorporating organic matter such as manure, compost and other litter in them. Likewise, the organic matter or humus mixed with the soil and upper layers of the subsoil may cause gravelly and sandy soils to be more retentive of moisture and less droughty. Such treatment may make them suitable for the growing of fruit crops.

FIG. 38.—A home garden that supplies fresh vegetables from early in the spring until late fall with abundant quantities for canning, freezing, and storing for late fall and winter uses in the fresh stage. (Mo. Agr. Exp. Sta.)

SIZE OF FRUIT GARDEN

In general, the fruit planting need not be extensive or large in order to produce an abundant fruit supply for home uses. If too large, there is usually a strong tendency to neglect it on account of considerable labor being required for good care and maintenance. Perhaps, the chief reason for waning of interest in home orchards or fruit plantings, has been due to overplanting.

The home fruit garden may in some instances be considered a hobby or side line. Consequently, the time required for it may be best suited to "after regular work hours" in the late afternoon or evening and again during the early morning before the main activities of the day are started. It should be understood, however, that such practices as spraying must be performed properly at exactly the right periods or the work may prove to be worthless. This operation as well as others may require some study and practice for desired results. Thus, the plantings should not be so large or extensive as to force the grower to neglect the required care and attention. Furthermore, it is well known that comparatively small fruit gardens well tended may produce many times more and better fruit than those covering much greater areas. For additional suggestions on size of plantings, age of bearing fruits and probable production consult the following table:

Number of Fruits and Possible Yield for Family of Six

Kind of Fruit	*Number of Plants*	*Approximate Age when Bearing Begins*	*Possible Annual Production at Full Bearing Age, with Good Care*
Tree Fruits (Standard Trees)		*Years*	
Apple (A and B)	6	5–8	50 bushels
Pear (B)	3	5–8	15 bushels
Peach (C)	3	3–4	12 bushels
Plum (B)	3	4–7	6 bushels
Sour Cherry	2	4–5	120 quarts
Sweet Cherry (B and D)	2	5–7	140 quarts
Small Fruits			
Grape	20	3	250 lbs. (5 bushels)
Strawberry	250	2	150 quarts
Blackberry (E)	40	2	45 quarts
Red Raspberry (E)	30	2	35 quarts
Gooseberry	10	3	40 quarts
Currant	12	3	35 quarts

(A) The plantings suggested may produce ample amounts of fruit in fresh state, for canning, freezing and preserving for family of six including hired help.
(B) Provide cross-pollination by planting more than one variety.
(C) May bear crops infrequently in northern sections.
(D) In general not well adapted to the United States as a whole. Cropping irregular except in Pacific Coast States.
(E) Black and red raspberry plantings should be separated by a distance of 200 to 300 feet on account of mosaic diseases. (Adapted from Growing Fruit for Home Use, Ill. Agr. Ext. Cir. 524 by Victor W. Kelly, 1942.)

PLANTING STOCK

The best nursery stock obtainable may prove to be the cheapest in the long run. It is obvious that vigorous fruit trees and small fruits properly grown and handled are essential for good fruit production. One may save a few dollars by purchasing low grade stock, but poor stands of trees and plants may occur and unsatisfactory growth is apt to follow planting. Such setbacks may more than offset the initial savings.

WHEN TO PLANT

In the northern districts, fruit trees should be planted in the early spring as there is then usually less danger from winter cold. However, in sections toward the central and southern portions of the United States late fall and early winter planting and mulching the soil about trees and plants may give satisfactory results. The strawberries and cane fruits such as blackberries, raspberries and dewberries are in general spring planted except in the southern areas where they may often be planted successfully through late fall, winter and early spring. Other small fruits including grapes may be planted in the fall toward the south and in the early spring for northern sections. Where fall planting is practiced, fully dormant stock should be used because weak growth and poor results may follow the transplanting of immature plants from which the leaves have been stripped.

Suggested Planting Ages of Trees and Vines

Apples, 1 yr. 3′–4′ whips
Pears, 1 yr. 3′–4′ whips
Peaches, 1 yr. 3′–4′ branched
Peaches June budded, 2′–3′
Plums, 1 yr. 3′–4′ whips
Apricots, 2 yr. 3′–5′ well branched
Cherries, 1 yr. 3′–4′ well branched
Quinces, 2 yr. 3′–5′ well branched
Nut Trees, 1 yr. 4′–6′ whips
Figs, 1 yr. Stocky
Grapes, 1 yr. Stocky
Blackberries, 1 yr. Stocky
Raspberries, 1 yr. Stocky
Strawberries, 1 yr. (light colored roots)

DWARF OR STANDARD TREES

Home fruit gardeners may often be thrilled and much interested in the prospects from planting dwarf fruit trees. It is true that dwarf apple and pear trees require less space in the garden plot where planting room may be very limited. Such trees may facilitate spraying, pruning and harvesting practices and they usually come into bearing earlier than the so-called standard trees.

On the other hand, dwarf trees are shorter of life and, with comparatively limited fruit bearing surfaces, yields are usually small. As they are generally propagated on less hardy roots than standard trees, they may suffer seriously in the colder sections from winter cold injury. Root development may be poor and unless tree braces are provided a considerable percentage of trees may be blown over, and broken off at the base during strong wind storms.

The convenience therefore, of smaller trees and earlier bearing may be out-weighed by the advantages that may be secured by planting standard trees. Dwarf trees are undergoing serious investigations due to the demand for them. However, until such faults or short-comings as susceptibility to winter cold and wind damage are overcome, fruit gardeners may profit most through planting and culture of the standard trees.

SPACING OF TREES AND PLANTS

Naturally one of the important problems of the producer when planning for the home fruit garden is how far apart should the trees and small fruits be set. Rarely if ever are the plants set too far apart but one of the most common mistakes made in fruit growing is close planting. With apple trees set on the square plan 36 × 36 feet or 40 × 40 feet and grapes planted 10 × 10 feet, the trees and vines appear very thin on the planting plot. However, the guide should be the full grown apple tree and grape vine. While the plants are young and coming into bearing vegetable crops for home uses may be grown between the rows. Soil building crops like cow-peas, soybeans, winter vetch, rye, buck wheat and others may be grown and plowed under as leguminous and non-leguminous cover crops.

Planting Distances for Fruits

Fruit	*Spacing Distance feet*	*Fruit*	*Spacing Distance feet*
Apple (standard trees)	36 to 40	Quince	20 × 20
Apple (dwarf)	20 × 20	Grape	10 × 10
Peach	25 × 25	Strawberry	4 × 1½
Pear (standard trees)	30 × 30	Red Raspberry	8 × 3
Pear (dwarf)	18 × 18	Blackberry and Dewberry	8 × 3
Plum (European)	30 × 30	Black and purple Raspberry	8 × 4
Plum (other varieties)	25 × 25	Currant and Gooseberry	8 × 5

Number of Trees or Plants for an Acre

Spaced at various distances apart the following table will show how many trees or plants are needed to plant an acre.

Feet Apart	*Square Method Number of Trees*	*Feet Apart*	*Square Method Number of Trees*
60	12	12	302
50	18	10	435
40	27	8	608
35	35	6	1201
30	48	5	1742
25	70	4	2722
20	109	3	4840
18	134	2	10,890
15	194	1	43,560

To estimate the number of trees and plants for planting an acre multiply the distance in the row by the distance between the rows. Then divide this

sum into the number of square feet (43,560) in an acre. The quotient or figures obtained equals the number of trees, for example, required to plant an acre by the square method.

Where the land is sloping or rolling and requires contouring or terracing for the growing of farm crops, the fruit trees and plants should be planted on the contour instead of on the square plan. About the same number of trees and plants per acre as for the square system will be needed.

DAMAGE TO FRUITS BY LOW TEMPERATURES

Definite temperatures at which fruit plants or their flower buds may be killed for all sections of the country are not available. The records show that the amount of injury may be influenced by the growth conditions of the plant, by the weather preceding the severe winter cold, and by still other environmental conditions. Also, observations indicate that temperatures ranging from 28° to 35° F. below zero may cause serious injury to such northern apple varieties as Baldwin and Gravenstein. Hardier varieties like Courtland, McIntosh, and Melba may be able to withstand these low temperatures without injury. Apple buds are known to survive 30° F. below zero but injury may depend largely upon the factors mentioned above. Peach trees and other fruit trees of similar hardiness like sweet cherries, Japanese plums, apricots, quinces and others may be killed or show considerable tree injury at 25° F. below zero and their fruit buds rarely survive in sufficient numbers to produce a crop when the temperature drops to 15° F. below zero.

Winter hardiness of the different kinds of fruit trees diminishes approximately in the following order: American plums, crab apples, apples, sour cherries, European plums, pears, Japanese plums, sweet cherries and peaches. This arrangement may give one a rough guide, but the damages may vary considerably due to weather conditions and the previous care of the trees. For instance, cherry trees defoliated by leaf spot, or peach trees that have lost their leaves by arsenical spray injury are usually less resistant than trees that have retained their leaves. For additional information on winter cold injury consult Chapter 13 of this book.

IRRIGATION

In the semiarid sections, where the rainfall occurs generally in the winter season, irrigation may be essential to successful fruit growing. Even in humid areas where water may be obtained economically, fruit growers have found from experience that the instillation of irrigating systems adapted to their needs often pays good returns. This is true because it enables them to avert losses which otherwise would be suffered in severe drought periods. In fact, producers often state in the sections where rainfall is considered ample, that an irrigation system is needed at certain critical periods practically every year for profitable production and high quality fruit.

Suggested Varieties for Home Fruit Garden
(Arranged in Order of Ripening)

Fruit	*Northern Sections*	*Central Sections*	*Southern Sections*
Apples (A, B) (Summer)	Transparent, Wealthy	Transparent, Wealthy	Transparent, S. Champion
Early Fall	McIntosh, Jonathan	Jonathan, Golden Delicious	Jonathan, Golden Delicious
Fall–Winter	Golden Delicious, Cortland, Haralson	Golden Delicious, Turley, Winesap	Golden Delicious, Turley, Stayman
Pears (B)	Garber, Kieffer, Seckel, Mendel	Tyson, Lincoln, Seckel, Kieffer	Seckel, Douglas, Garber, Kieffer
Peaches		Carman, Champion, Hale-haven, Early Elberta, Elberta	Golden Jubilee, Carman, Champion, Halehaven, Early Elberta
Plums (B) Hybrids	Underwood, Superior, Monitor (D)	Underwood, Superior, Monitor (D)	
European (B, C)	Moore, Arctic, Lombard	Renie Claude, Stanley, Mount Royal	Renie Claude, Stanley
Japanese (B, C)			Burbank, Abundance
Damson			Shropshire
Apricots (C)		Stella, Moorehark	Stella, Moorehark
Cherries, Sour	Early Richmond Montmorency	Early Richmond Montmorency	Early Richmond, Montmorency
Sweet		Gov. Wood, Napoleon	Gov. Wood, Napoleon
Grapes	Fredonia (black) Portland (white) Lucile (red) Concord (black)	Fredonia (black) Portland (white) Agawam (red) Concord (black)	Moore (black) Caco (red) Niagara (white) Concord (black)

Strawberries	Premier, Dunlap,	Blakemore, Premier, Aroma	Blakemore, Aroma, Klondike, Klonmore
(Everbearing)	Streamline, Wayzata	Superfection, Brilliant, Wayzata	Redstar, Rockhill
Raspberry (Red)	Chief, Latham, Cuthbert	Latham, Chief, Newburg	Ranere, Sunrise
(Everbearing)	Indian Summer	Indian Summer	Indian Summer
Black	Bristol, Logan, Quillen	Bristol, Logan, Quillen	Logan, St. Regis
Purple	Sodus	Sodus, Potomac	Potomac
Blackberries	Eldorado (for extreme northern areas may not be hardy)	Eldorado, Early Harvest, Alfred	Early Harvest, Alfred, Eldorado
Gooseberries	Dowing, Poorman	Poorman, Pixwell, Glendale	Poorman, Glendale
Currants	Red Lake, White Grape	Wilder (red)	Wilder (red)
Black Walnuts (E)	Thomas, Ohio	Thomas, Stabler	Thomas, Stabler
Pecans (B, E)		Major, Indiana	Stuart, Success, Schley
Hickories (B, E) (hybrids)		McAlister, Rockville Please	McAlister, Rockville Please

(A) Red Sports of apples are preferred if available.
(B) Plant more than one variety to provide cross-pollination.
(C) Plum, apricot and sweet cherry varieties may be damaged by very low temperatures.
(D) For the Monitor plum Surprise is suggested as a pollinizer.
(E) All young seedling nut trees can be changed to named varieties by budding and grafting.
If other varieties or wider choices are desired, write to your State College of Agriculture for suggestions.
Adapted from Growing Fruit for Home Use (Ill. Agr. Ext. Cir. 524 by Victor W. Kelly, 1942).

Several different systems of applying irrigation water are in more or less general use. Furthermore, they may be adapted to both commercial and home fruit plantings. In the overhead spray system, the water is distributed through pipes supported on posts established at intervals in the orchard or planting. The pipes are perforated with small holes and when the water pressure is applied it may be distributed over the area. However, the rotary, portable sprinkler system is now most serviceable and popular for all land surfaces.

FIG. 39.—Farm ponds may supply water for irrigation, spraying for insect and disease control, water for livestock, and different forms of wildlife. (Mo. Agr. Exp. Sta.)

The furrow method of distributing the water is employed successfully in some districts. The furrows are made between the rows of fruit plants and are usually 3 to 4 feet apart. In this system a uniform tract of land that slopes gently from the water supply is used. On hilly or broken land, however, the furrows are made approximately parallel with the slopes.

The basin system is also used and it may be especially adapted to the home fruit planting. A large basin is prepared about each tree by mounding up a ridge of soil around the trees at distances ranging from about 8 to 14 feet from them. Pipes may be employed for conveying the water into the basin or other methods such as hauling by tanks or use of garden hose may be adapted. Additional information in regard to irrigation may be obtained from State Experiment Stations and the United States Department of Agriculture.

SOIL MANAGEMENT PRACTICES

For all fruit trees and vines during the first 4 or 5 years after planting on level or nearly level land, clean cultivation and the use of intercrops of vegetables and soil improving cover crops are suggested. As the trees approach bearing age, it will generally be best to establish a grass sod except in the case of peaches. In a mature orchard blue grass makes a good ground cover in many sections.

On steep slopes apples, pears and grapes as well as plums, cherries and peaches may be planted successfully in sod if an area about 3 to 4 feet wide around the base of each tree is kept cultivated and fertilized as needed

for good growth. No matter what the type of culture may be, the trees should be kept vigorous and thrifty, particularly until fruit production begins.

It is possible of course to overdo fertilization and cultivation and cause the trees to become too vegetative. When this happens, the pear trees especially are likely to suffer from attacks of fire blight and all the young trees may continue growth late enough in fall and early winter to be damaged by cold.

Young trees, on the other hand, that make a poor growth (4 to 6 inches, yearly) induced by inadequate or no cultivation, fertilization or spraying may subject the apple trees and peach especially to serious attacks of bores. The fruit trees and vines may enter the winter in a weakened condition and be susceptible to injury by winter cold. Like other crops such as sweet corn, cabbage, beans and Irish potatoes, fruit trees and vines must make satisfactory growth and development to prove worthwhile.

Fertilizers.—On fertile soils it may not be wise to apply a fertilizer at time of planting. Moderate applications of fertilizers including manure if used properly is likely to be of value in most instances. For some soils and climatic conditions, a commercial nitrogen fertilizer alone may be sufficient to produce the growth and development desired, while in other cases a combination fertilizer such as 4–8–8, 4–12–4 or some other so-called complete fertilizer will give the most satisfactory result.

For young or non-bearing trees and vines the fertilizer is usually applied broadcast in an area ranging from about 12 to 14 inches from the trees to as much as a few feet beyond the trunks or spread of branches. The amount of fertilizer to apply depends upon the need and may vary considerably. Following planting about 100 to 200 pounds per acre is generally found to be ample. The application of excessive amounts may result in burning and killing roots. As the plants or trees grow older increased amounts from year to year may be required.

Better growth is generally made and there is less likelihood of injury if fertilizer applications are made in early spring. Later in the spring where plants show a need for stimulation by making a small amount of growth or by developing foliage of a yellowish color, an additional light application of a quickly available nitrogen fertilizer, such as ammonium nitrate or nitrate of soda may be made.

The use of manure in the fruit planting cannot be overemphasized. Its value may be particularly striking where applications are made soon after setting. Furthermore, manure seldom damages newly set plants when applied as surface applications and it may promote equally as good or even better growth than chemical fertilizers where applied alone.

Cover Crops Aid.—Cover crops should be considered in the soil handling practices. These may add organic matter, aid in stopping soil erosion, conserve soil nutrients and where plowed down or disked into the soil increase soil aeration and supply added soil nutrients.

Cultivation and the use of cover crops is an established and much used method of keeping up the vigor and fruitfulness of fruit crops. The land may be cultivated from spring to midsummer after which a cover crop is sown. In some instances instead of sowing a cover crop, grass and

other vegetation are allowed to grow and cover the ground during late summer, fall and winter. The cover crop is usually disked or plowed under in early spring. The practice may be repeated and changed according to the need while tree fruits are coming into bearing.

The cover crops used in the fruit growing sections of the country may vary widely due to the differences in climate, soils and farming practices. Some of the crops used extensively as both cover crops and green manure crops are legumes such as cowpeas, soybeans and winter vetch. Non-legumes like rye, barley, wheat, buckwheat, millet and the natural vegetation that follows the stopping of cultivation in late summer is employed widely.

The green manure crop differs from the cover crop in that it is sown in the spring or early summer and disked or plowed into the soil during the same season while it is green and succulent. Green manure crops may prove to be especially valuable in preparing land for the growing of small fruits such as strawberries, raspberries, blackberries and others. Various kinds of rapid growing crops may be used providing they may be plowed under in time to sow a fall and winter cover crop.

Mulching and Fertilizing the Young Orchard.—Most tree fruits with the exception of peaches respond in growth and development as well from mulching as from clean cultivation. The mulch should be heavy enough to keep down the growth of grass and weeds. Also, in most instances it should be supplemented through the use of manure or commercial nitrogen fertilizers. Manure spread mainly around the trees and at least several feet beyond the branches may, if containing sufficient litter, meet the requirements for a mulch. All mulches should be kept a foot or more away from the tree trunks for protection against damage by field mice. Commercial nitrogen fertilizers or complete fertilizers may be used broadcast on top of the mulch in early spring at the rate of ¼ to ½ pound per tree soon after planting. The fertilizer should be placed some 12 to 16 inches from the base of the tree trunks and extended outward as the tree grows older.

It will be necessary to renew the mulch each year unless comparatively heavy applications are made in alternate years. The fertilization practices should be continued each year and the amount used increased at about the rate of ½ pound for each tree per year. However, the gardener must observe the growth carefully. If it appears to be too great (more than 18 to 24 inches annually) or branch development seems, to be weak and short (about 5 to 10 inches annually) some adjustments are in order in each case. Withhold fertilization and cultivation in the first example or where less growth is desired. In the second example which is most common, it is obvious that more growth is needed. Correct the growth problem by increasing fertilization and cultivation, one or both as required for good growth and fruiting.

The mulch may be continued until the trees come into bearing. If the plan is to maintain the trees in sod after bearing begins, which is generally the adopted practice, some modifications in the methods may be made. For mature trees sod crops are popular because all orchard operations may be carried forward under this system with the least interference.

Erosion is prevented and the rain water intake is increased. Large quantities of organic matter or humus is added to the soil which helps in the retention of soil moisture.

A good legume sod may add more nitrogen to the soil than the normally applied commercial form of nitrogen. Most orchardists prefer to keep a bluegrass sod. To make it most serviceable an abundance of soil nitrogen is required. A bluegrass-white clover mixture, therefore, may be needed. In establishing the legumes the trash mulch method of seeding has been very successful. Through the use of a disk harrow or orchard cultivator the orchard soil cover is pulverized leaving as much trash on top of the soil as possible. This work is usually done in late fall or early spring and the legume seeding is made in the early srping.

The lime requirement of the soil should be satisfied for the growing of good covers of bluegrass and clover. A ph test of 6.6 to 7.0 should prove satisfactory. An application of about 500 pounds per acre of 20% super phosphate or a similar amount of 0–12–12 per acre every 3 to 5 years may be needed.

The choice of the legume to use may depend upon the soil type, age of orchard and amount of shading, and facilities for keeping the cover clipped. Ladio clover may make an ideal legume and it does not compete with the trees for soil moisture. Sweet clover is one of the best soil builders but it does not respond to close clipping. It is better suited to use in the young orchard. White clover and bluegrass make a good combination although some years the legume stand may be depleted. Both red and alsike clovers may be used but usually they do not last for more than one or two seasons.

THE COMPOST HEAP IS VALUABLE

The methods of making your own compost heap or fertilizer factory through the uses of vegetable and animal refuse may vary considerably in the different sections of the country. However, the principle is essentially the same for all the different methods and procedures that have been developed.

Fruit and vegetable gardeners have found that when plant and animal products are added to the soil, much will usually be gained if it is thoroughly decomposed. The compost then becomes quickly incorporated in the soil and the plant food soon becomes available.

The selection of a good site is important. A plot protected on the north, east and west by a wall, fence, or hedge may prove to be an advantage. Such protection prevents the heap from exposure to excessive drafts which may dry it out. The compost pile should be close to the fruit garden and near the water supply. A fairly flat location that may supply good water drainages is preferred and space should be available for the accumulation of needed materials.

Perhaps the heap should not be less in size than about 5 feet square. This may depend, however, upon the amount of material desired for use as a fertilizer. Various kinds of materials may be used in the compost heap. Some of the most common are organic substances (animal products or

waste), green vegetable matter or garbage, argicultural lime or wood ashes (needed to alkalize the decaying products), and ordinary top garden soil. Where kitchen waste or garbage is used, all fats and oils should be excluded from the heap.

The compost pile is constructed by making layers a few inches thick of green succulent materials such as weeds, kitchen garbage, vegetable tops and stems, grass clippings, leaves, old hay, etc. In order that air may enter from the bottom of the pile, the materials are often piled upon heavy branches placed on the soil at the bottom.

FIG. 40.—A good compost heap, the only organic fertilizer being used in an adjoining profitable home garden. (Mo. Agr. Exp. Sta.)

In starting the heap about 6 inches of waste materials are placed upon the branches at the bottom. Then 2 to 3 inches of organic materials such as animal products and manure may be added, after which about $\frac{1}{8}$ inch of agricultural lime or wood ashes may be sprinkled over the top. This process may be repeated until all the available materials are used. For good results the heap should not exceed a height of about 5 to 6 feet when completed.

To prevent the compost heap from drying out, the top layer of manure or vegetable litter and covering of soil may be made somewhat thicker than the lower layers. In about three weeks after starting, turn the materials in the pile with a pitchfork and repeat the process at intervals of 4 to 5 weeks. Apply water to the layers of the heap if required in order to keep the materials moist at all times but not soggy wet.

Materials like tomato vines, corn stalks, potato vines, shade tree leaves, and weed and grass cut from the borders may be made into useful plant

foods where they have been composted for several months or a year. However, where serious diseases infest the materials, they should be burned instead of being composted. The addition of quick lime to the layers of the compost pile hastens the decomposition of raw materials. In addition to manure, commercial fertilizers like ammonium nitrate, nitrate of soda, super phosphate and complete fertilizers such as 4 8 4, 4 12 4 and other combinations may be used. Even without fertilizers or lime, the composted materials may prove valuable in accelerating the growth of both tree and small fruits.

PREVENT LIVESTOCK INJURY

If the home fruit garden is made a pasture or range for livestock and poultry, the producer may not expect satisfactory results and returns. Perhaps there is no surer indication of the failure of the enterprise than through the employment of such practices. The trees and plants may be injured by the feeding of the livestock on the foliage, tender branches and bark of the trees and plants. Damage to the trunks and branches may be done by rubbing and the soil may be packed sufficiently by tramping to prevent good growth. Poultry, although less likely to cause damage, may, by scratching, destroy the vegetation and expose the roots and soil to serious drying.

Chapter 16

Diseases and Insects, Sprays and Spraying

The discussions which follow are designed to give the reader a working knowledge of the fundamentals pertaining to the subjects listed above. Such fundamentals, fortunately, do not undergo rapid and spectacular changes in short periods of time. Consequently every student and grower should have the information in order to obtain a better understanding of Diseases and Insects and Sprays and Spraying.

It is realized that the spray schedules or charts given are subject to change yearly. They may not be entirely up-to-date or modern after one or a few years due to the unprecedented rapid changes that are now in progress and that have occurred in the past 6 to 8 years. However, a careful study of the schedules or charts is likely to be found worthwhile. This is true because the pests attacking the crops are not apt to change markedly; the methods and procedures will in general be much the same this year and may be for several years.

The knowledge gained, therefore, through such a study fits the individual admirably for the study and application of the current years recommendations by the State Agricultural Experiment Stations. Unless the student and grower are willing to apply themselves studiously in an effort to obtain a good working knowledge, little progress will be made. It will not be found necessary to commit to memory a long list of hard names of chemicals, diseases or insects. It is obvious the reader should know a few fungicides, insecticides, major diseases and insects, and the usual interval between sprays. More important, perhaps, is that the student and grower should know how to interpret and understand the spray calendar or chart. Frequent reference to it may be required during the spraying season. For the numerous details and suggestions with which spray operators and management should be familiar, consult carefully the latest recommendations of the State Experiment Stations.

DISEASES AND INSECTS

The prevention and control of diseases and insects injurious to fruit and vegetable crops constitutes a major problem for producers. It is estimated upon good authority that as much as 20 to 40 per cent of the total cost of commercial production is due to the expenditures for disease and insect control.

All will agree that this cost of preventing and controlling the ravages of diseases and insects, chiefly through spraying and dusting and the adoption of cultural practices unfavorable to the pests is heavy and often tremendous. Never-the-less if the grower is to produce marketable fruits and vegetables of high quality and stay in production, there is no escape from the costs of proper pest control measures. Furthermore, there is plenty of evidence to show that the higher the expenditures for pest control coupled with knowledge, good judgment and discretion, the greater may be the annual returns on the project or enterprise.

KNOWLEDGE OF DISEASES

The annual losses of fruit and vegetable crops from diseases are now considered greater than from any other cause. Such damage may be reduced materially or held in check sufficiently to make the growing of these crops profitable. To do so however, the producers are generally required to incorporate modern spraying practices and proper cultural methods in their annual production programs.

FUNGOUS DISEASES.—These diseases are caused by a low form of plant life. They are usually the most common and may affect foliage, stems and roots, as well as the fruits. Danger signs may consist of tiny brown or yellow spots and dead areas on the leaves and fruits. In general, the most effective control measures are preventive and are applied before infection occurs. To do this it may be necessary to keep the growing parts, fruits, leaves and stems covered with a fungicide. Hence the need for spraying or dusting at intervals of about 10 days or 2 weeks to keep the susceptible surfaces covered.

Fungous diseases are reproduced by means of spores or microscopic "seeds" and may be spread by the wind and rain. When deposited on fruits, leaves, stems and other succulent and growing parts particularly, they may germinate and grow like other seeds. A tiny germ tube enters the plant usually through breathing pores or wounds on the surface. Once an entrance is made in the tissues of the plant, the fungus may soon become established. It cannot then be destroyed without doing material or serious damage to the infected plant. The spores or germinating "seeds" of fungous diseases may be effectively destroyed before they enter or establish themselves in their host or food plant by proper spraying or dusting. For prevention or control, producers must know when spore disseminations occur and then endeavor to apply protective spray or dust coverages before infection takes place. Such sprays or dusts are called fungicides as they kill or prevent the growth of fungous diseases.

FUNGICIDES.—Some of the most common fungicides are lime-sulphur, Bordeaux, Ferbam, Elgetal, and other forms of sulphur and copper and organic fungicides manufactured and distributed under trade names.

BACTERIAL DISEASES.—These diseases are caused by microscopic plants or organisms known as bacteria (singular, bacterium). Bacteria are very minute and may be found in a number of different shapes and sizes. Perhaps the most common forms are rod-shaped and live in irregular masses,

in chains, or single. Reproduction is brought about by division or dividing in the middle. Each half then becomes a new plant. Bacteria, therefore, are able to multiply rapidly and millions may be produced within a few days from one organism.

Bacteria and fungi in many respects are much alike. However, it should be remembered that the chief difference is that bacteria multiply by cell division and the process is much more rapid than fungi reproduction through the development and spread of spores.

Bacteria may enter their food plants most often through wounds and abrasions on the tender or succulent plant parts as well as through the flower organs, stomata and lenticels. Dissemination or spread may be mainly by insects and to some extent by wind and rain. Furthermore, as reproduction is by means of cell division instead of through the production of spores, spraying and dusting practices, so effective against fungous diseases, may have little or no effect in the control of bacterial maladies.

Growers of vegetables and fruits prevent attacks of bacterial diseases chiefly through the use of resistant varieties. Much importance may be placed upon the starting of the project by using healthy, non-infected plants. The elimination of infected specimens and plant parts coupled with good sanitation practices may prove helpful. Where it is necessary to grow and fruit both infected varieties and susceptible sorts, a great deal may in some instances be accomplished through controlling plant growth. Fire blight of apples and pears, a bacterial disease, may be sighted as a good example of how growth control may affect bacterial maladies.

Virus Diseases.—There is still more to be learned in reference to the nature, control and prevention of virus diseases of fruits and vegetables than is true for fungous and bacterial disorders. The general and most important method of spread appears to be through insects as carriers. Infection may be transmitted by budding and grafting, the contamination of healthy plants with the sap or juice of diseased ones, and by root contact and mingling in the soil.

Common examples of virus diseases are the mosaics of tobacco, tomato, and potato. Peach yellows and aster yellows of long standing are typical for this group of disorders. Mosaic infection may cause the plants to exhibit discoloration and mottling of the foliage, while those injured by the so-called yellows may produce yellow colored leaves, lack color and develop off colors in the flowers. These changes may be accompanied by the slowing-up of growth. As a result the damaged plants may be stunted and made less fruitful. Malformations are also likely to occur.

Methods of control and prevention now emphasized consist of the destruction of virus-carrying insects. Some designated as important carriers are the plant sucking types such as aphids and plant bugs. Contact sprays and dusts are used against these insects. Sanitation or clean-up practices consisting of the removal and burning of infected plants including roots, stems and branches is another suggestion.

Starting new plantings with disease-free stock on soils made as free as possible from virus contaminated refuse should prove helpful. The planting of resistant varieties and strains may also constitute one of the most worth-

while procedures in combating and producing crops where virus diseases are prevalent.

Insecticides and Fungicides.—A chemical or product used as a spray or dust to destroy or control insects is known as an insecticide. On the other hand, a chemical or product used in a similar manner to destroy and control fungous diseases is called a fungicide.

KNOWLEDGE OF INSECTS

The adoption of proper methods of prevention and control of insects attacking fruit and vegetable crops may reduce losses materially. The home program, in many cases, may not require regular spraying or dusting practices, as important as they are in combating insects. In fact, the shaping of garden and orchard practice along lines unfavorable to the insects concerned, may be very helpful. In any event it will go a long way toward supplementing the applications of spray and dust insecticides.

Both home and commercial garden and orchard practices may include judicious rotation of crops, cleaning fields, fence rows, orchards, ravines and waste areas of weeds, bunch grass and the like. Still other fruit and garden practices consist of fall or early winter plowing in preparation for planting early or late to avoid insect attacks. Other insect control practices used by growers include the destruction of infested crops soon after harvest by plowing under deeply or by cutting and burning, and by growing resistant varieties.

To combat insects intelligently and effectively the grower must know the main characteristics of the different groups; how the insects have fitted themselves to survive and multiply; what methods of control are suited to a particular group; how their life history, development and habits make it possible to destroy them with sprays or avoid their damage by planting early or late. Such information is sure to give producers an advantage in executing programs designed for their benefit. Once growers become acquainted with the reasons for the practices adopted, they are likely to work with efficiency and enthusiasm.

Time may be saved by knowing when and how to proceed. Armed with information on the feeding habits of the insects, and knowledge on over-wintering habits may enable growers to strike the insects at the weakest points in their growth and development. Equipped with these and other facts about insects, the grower knows the *what*, *when* and *why* of his fight against the insects. It is obvious, therefore, that he is much more likely to be successful.

Food Habits Important. Insects may be divided roughly into two great classes on the basis of their mouth parts and habits of feeding. First, the chewing types which actually eat the stems, leaves, and fruits of plants. The apple worms and grasshoppers are good examples of chewing insects. Such insects may usually be destroyed by dusting or spraying the infested plants with stomach poisons like lead arsenate and chlordane. It may be necessary to spray or dust so thoroughly that when the insects feed they must consume the poisons.

Second, the plant juice sucking types are made up of such groups as the aphids or plant lice, the squash and pumpkin bugs and others which have piercing and sucking mouth parts. These insects are provided with long sucking beaks which enables them to draw out the plant juices. It is practically impossible to poison the sucking insects because they are capable of inserting their sharp sucking beaks and drawing out plant juices from beneath the surface of fruits and foliage without taking any of the poison dusts or sprays that may have been applied. These insects, therefore, require a contact spray or dust for their destruction and control. Contact insecticides like nicotine sulphates, oil emulsions, and others are used. These must cover thoroughly the bodies of the insects for good control. Still other new chemicals are now being used widely and successfully. Some of these are effective for the destruction of both sucking and chewing insects. For example, parathion is a stomach poison, contact spray or dust and a fumigant. Other new insecticides are DDT, TDE, and aldrin.

COMBINATION SPRAYS AND DUSTS.—In the fight against disease and insects combinations of fungicides and insecticides are used to facilitate spraying and dusting operations. For example, in the pink or cluster bud spray for apples, microfine sulphur may be used for apple scab control, lead arsenate for codling moth, and lindane for plant lice or aphids. In fact, most of the applications of sprays and dusts may contain two or more kinds of spraying materials made up of both fungicides and insecticides.

SPRAY AND DUST MATERIALS AND EFFECTIVENESS

Materials used for spraying and dusting are sometimes condemned as "no good" when failures to obtain satisfactory control of diseases and insects occurs. Properly tested spraying and dusting chemicals if used according to the manufacturers' directions, have generally given satisfactory control of the pests for which they were recommended.

Improper combinations of spray materials, faulty methods of application, under varying weather conditions may result in as much or more damage to fruit and foliage as that caused by the insects and diseases on unsprayed trees. Furthermore, it is important when selecting spraying and dusting materials, that consideration be given to their injurious effects on the plants. Objectional spray residues may be left on edible fruits, stems and leaves and cause the products to be discriminated against on the markets. Spray residue problems are usually avoided by discontinuing sprays and dusts as the harvest season approaches.

SPRAY CALENDARS OR CHARTS

Every State Agricultural Experiment Station in the United States issues soon after the first of the year directions or suggestions for spraying and dusting fruit and vegetable crops. At the present time these so-called calendars or charts are particularly important because new spraying and dusting products are being perfected and placed on the markets nearly every year. Spraying information of the previous year may be out

of date or ready to be replaced as new products may be more effective against diseases and insects than the older materials. The new spray chemicals may also be less likely to russet or burn foliage and fruits.

SOME ESSENTIALS FOR SUCCESSFUL SPRAYING AND DUSTING

Spraying and dusting may be the most important practice in growing profitable crops of fruits and vegetables. Even though the grower may use

FIG. 41.—Effective spraying with modern equipment for commercial producers. (Courtesy of American Fruit Grower.)

the best known cultural practices including cultivating, pruning and fertilization, if he fails to spray or dust thoroughly and at the right time he may not succeed. The cost may be considerable but when compared with the returns it will bring, the producer can well afford to give the practices his most earnest attention and consideration.

Thoroughness of application of the sprays and dusts made at the proper time are the most important essentials. The right materials must be used at the right time and in the right way. If the spray does not entirely cover the parts of the plant needing protection, it is not likely to be effective. Furthermore, if the spray applications are not applied often enough or

APPLE AND PEAR SPRAYING SCHEDULE

Application	*Purpose*	*When to Apply*	*Materials in 100 Gallons of Water*
Dormant	Scale, red mite	Before buds open	Dormant oil, 3 gal. actual
Prepink	Apple scab	Before flower buds show pink	Lime sulphur, 2 gal. or Dry lime sulphur, 8 lb.
Pink	Apple scab	When cluster buds separate	Same as prepink spray or Microfine sulphur, 8 lb.
Bloom	Apple scab, Cedar and quince rust	About 20% blossoms open	Microfine sulphur, 3 lb. 70% Ferbam, ½ lb.
Calyx	Codling moth, scab, curculio, red-banded leaf roller, rust	¾ petals have fallen	Lead arsentate, 3 lb. 70% Ferbam, ½ lb. Microfine sulphur, 3 lb.
Calyx top-off	For same pests as calyx spray	Soon after calyx to top ⅓ of trees	Same as for Calyx spray
1st Cover	Curculio, codling moth, scab, blotch, rust, leaf roller	7 days after calyx top-off spray	Lead arsenate, 3 lb. 70% Ferbam, 1 lb.
2nd Cover	Codling moth, red-banded leaf roller, leaf hopper, curculio, scab, and blotch	7 days after 1st cover spray	Lead arsenate, 2 lb. DDT, ½ lb. actual, 70% Ferbam, ½ lb.
3rd Cover	Codling moth, scale, bitter rot, black rot	10 days after 2nd cover spray	DDT 1 lb. actual Copper sulfate, ½ lb. Hydrated lime, 1 lb.
	If red-banded leaf roller is serious		TDE, 1 lb. actual added to above materials
4th Cover	Codling moth, scale, bitter rot, black rot	10 days after 3rd cover spray	Same as for 3rd cover
5th Cover	Codling moth	14 days after 3rd cover	Same as for 3rd cover
6th Cover	2nd and 3rd brood codling moth	2 weeks after 5th cover. Make 2 to 3 sprays 10 to 12 days apart	DDT, 1 lb. actual. If mites are present add Aramite, Orthomite or Niagaramite
Special sprays	Red-banded leaf roller and other pests	When fruit injury occurs intervals of about 12 to 14 days to 2 wks. harvest time	TDE, 1 lb. actual. May add copper sulfate and lime for diseases

at about 10-to-14 day intervals to keep the fruit and foliage of the crops covered, effective results may not follow. It may be just as essential and important to continue the sprays or dusts up until within a few weeks of harvest time. This is true because late broods of the codling moth, occurrence of early or late blight, or an attack of brown rot on stone fruits, may ruin a crop on account of the applications being stopped too soon.

Spray Schedule for Peaches and Apricots

Application	*Purpose*	*When to Apply*	*Materials in 100 Gallons of Water*
Dormant	San Jose and Forbes scale, red mite and leaf curl	Before buds swell	Dormant oils, 3 gal. Actual, Copper sulfate, 4 lb. Hydrated lime, 3 lb.
	For leaf curl only	Same as above	Copper sulfate, 4 lb. Hydrated lime, 3 lb. or Lime sulphur, 5 gal.
Pre-bloom	Brown rot, blossom blight, catfacing pests	Early to full bloom	DDT, 1 lb. actual, Microfine sulphur, 3 lb. "Phygon XL", $\frac{1}{4}$ lb.
Petal fall	Curculio, brown rot, catfacing pests	After petals fall	Methoxychlor, or Chlordane, 1 lb. actual. Microfine sulfur, 6 lb.
Shuck-split	Curculio, catfacing, brown rot	About $\frac{1}{4}$ shucks are splitting	Same as petal fall spray
1st Cover	Curculio and scab	10 days after shuck split	Same as petal fall spray
2nd Cover	Curculio and scab	10 days after 1st cover	Same as petal fall spray
3rd Cover	Curculio, Oriental moth, scab, brown rot	10 days after 2nd cover	Methoxychlor, 1 lb. actual. Microfine sulphur, 6 lb.
4th Cover	Oriental fruit moth	7 days after 3rd cover	DDT, 1 lb. actual
5th Cover	Curculio, Oriental moth, brown rot	1 month before harvest	Microfine sulphur, 8 lb. Methoxychlor, 1 lb. actual
	If leaf rollers present		Add TDE, 1 lb. actual
Later Sprays If Needed	Brown rot	10-day intervals up to 14 days of harvest	Microfine sulphur, 8 lb.

Commercial peach growers are using parathion for the control of scale and other insects attacking peaches. The most commonly used new peach insecticides now in use are methoxychlor, EPN and parathion.

No two plantings are alike in regard to the occurrence or the severity of attack of the common injurious diseases and insects. Where the grower, therefore, has sprayed his horticultural crops properly for a number of years and knows the insects and diseases that are present, he may be able

Spring and Summer Dust Schedule for Peaches and Apricots

(Material-Benzene Hexachloride)

Application	*Purpose*	*When to Apply*	*Dust Formulas*
Bloom	Catfacing, blossom blight	Early to full bloom	Com. DDT sulphur dust or "Phygon"
Petal fall	Curculio, catfacing, brown rot	When petals are off	Com. Benzene Hexachloride dust
Shuck split	Curculio, catfacing, brown rot	As shucks begin to crack	Same as petal fall
1st Cover	Curculio and scab	Shucks $\frac{2}{3}$ off	Same as petal fall
2nd Cover	Curculio and scab	7 days after 1st cover	Same as petal fall
3rd Cover	Curculio and scab	7 days after 2nd cover	Same as petal fall
4th Cover	Curculio	7 days after 3rd cover	Same as petal fall
5th, 6th and 7th Covers	Curculio and Oriental moth	7-day periods after 4th cover	Same as petal fall plus addition 5% DDT
8th Cover	Curculio, Oriental, brown rot	Month before harvest	Same as for 5th, 6th and 7th Covers

Spray Schedule for Cherries

Application	*Purpose*	*When to Apply*	*Materials in 100 Gallons of Water*
Dormant	Forbes scale	Before buds start opening	Dormant oil, 3 gal.
Ground spray	Leaf spot control	Before buds start opening	"Elgetol", $\frac{1}{2}$ gal. About 500 gal. per acre
1st Cover	Brown rot, leaf spot, curculio, slugs	Soon after shucks fall	Lead arsenate, 3 lb. or Methoxychlor. 70% Ferbam, $1\frac{1}{2}$ lb. Soy bean flour, $\frac{1}{4}$ lb.
2nd Cover	Brown rot, leaf spot, curculio, slugs	10 days after 1st cover. If needed at 10-day intervals later	Same as for 1st cover
Later sprays	Leaf spot	Soon after harvest	70% Ferbam, $1\frac{1}{2}$ lb.
	Cherry slugs	In August	Lead arsenate, 2 lb. or Hydrated lime, 6 lb.

Spray Schedule for Plums

Application	*Purpose*	*When to Apply*	*Materials in 100 Gallons of Water*
Dormant	Scale insects	Before buds start opening	Dormant oil, 3 gal.
1st Cover	Curculio	Soon after shucks fall	Lead arsenate, 3 lb. or Methoxychlor. Copper sulfate, 1 lb. Hydrated lime, 2 lb.
2nd Cover	Curculio	10 days after 1st cover	Same as for 1st cover
Later sprays	Brown rot, mainly	Continue 10–12-day intervals to within few days of harvest	Microfine wettable sulphur, 8 lb.
	If aphids serious	As needed	Lyndane $\frac{1}{2}$ lb. 25%

to change or vary spraying suggestions, making the interval between applications longer or shorter as required. He may change also the kinds and proportions of spraying chemicals. If he knows his conditions and has studied his problems carefully, the alternations made may be beneficial and at the same time less expensive. On the other hand, if he does not know his insect and disease problems, it will generally be best to follow carefully the recommendations of the State Agricultural Experiment Station.

Moreover, in late winter or early spring is the season of the year when it behoves the producer to see that spraying outfits are in good working order and ready to be put into operation without delay. It is also of paramount importance to have on hand adequate supplies of insecticides, fungicides, equipment, and repair parts to prevent stoppage, break-downs and delays that may occur. Such materials, equipment, and repair parts may be much more difficult to secure during the height of the spraying season than before the spraying work begins.

AMOUNT OF SPRAY FOR FRUIT TREES

A practical and easy method of determining the number of gallons of dilute spray for fruit trees follows:

For example the dormant spray for apple trees may be determined by dividing the age of the trees by 4 to find the number of gallons needed per tree. For pink spray, divide by 3; for calyx spray, divide by 2; for the sprays that follow, divide by 1.5.

For example, a 12-year-old apple tree should receive approximately the following amounts:

Dormant and prepink bud stages of growth	3 gallons
Pink bud stage of growth	4 gallons
Calyx after bloom stage of growth	6 gallons
Each following spray about	$8\frac{1}{2}$ gallons

Spraying and Dusting Other Crops

For spraying and dusting other fruits and vegetable crops information may be found in the chapter pertaining to the particular fruit or vegetable. Furthermore, insect and disease control charts or programs for vegetables may be consulted near the close of Chapter 23.

Other Fungicides and Insecticides

So many new fungicides and insecticides have been introduced during recent years, producers of fruit and vegetable crops, now have a wide range of materials, from which selections may be made. All of these new materials, therefore, have not been mentioned or suggested for use. Some that have been omitted may be equal to the ones listed or even superior for certain purposes. However, the purpose has been to familiarize the

reader with the spray and dust materials that now appear to meet most needs and to acquaint him with the make up and use of spray and dust schedules.

CONCENTRATE SPRAYING

There is now widespread and keen interest in concentrate spraying. The method of application to fruit trees is by means of ground equipment. The machines used avoid the handling of large quantities of water and heavy equipment. The ease and rate of spray coverage may be increased at reduced cost.

Fig. 42.—Power spraying equipment suitable for both the home fruit garden and the commercial orchard. (Courtesy of American Fruit Grower.)

As a partial substitute for water an air blast is employed. In so doing, the amount of spray material in 100 gallons of water may be increased from two, four or even to eight times the normal amount used. The practice is in reality a new and additional effort to find a more economical method of spraying orchards.

The air blast employed carries the spray to the trees in the form of a very fine mist. Spray deposits on the fruit, leaves, stems and bark is in the form of finely divided droplets. Deposits of spray materials are generally retentive, adhere effectively and leave a satisfactory finish on surfaces of fruit and foliage.

Cornell University, New York, studies in more than 100 apple orchards during the past two years have shown highly variable results. In general, the concentrate machines were economical in both man-hours and machine-hours. Also, the total cost of spray materials was low. However, the control of insects and diseases varied from excellent to poor. In fact, the control was often not quite as good as through the use of regular dilute sprayers.

Specialized equipment such as liquid dusters, speed sprayers, mist blowers and others are used for concentrate spray applications. The one "best" sprayer has not been found or determined. The most powerful machines offer advantages on the one hand while the less powerful ones are best suited for other purposes.

Information upon concentrate spraying from practically all commercial fruit growing sections of the country indicates that the methods are worthy of further study and investigation. This is true in spite of the present limitations and shortcomings.

Chapter 17

Growing Vegetable Crops

PERENNIALS, CORN CROPS AND IRRIGATION

SINCE about 1920, particularly, vegetable crops and production have increased rapidly. This has been brought about chiefly as a result of the development of more efficient marketing methods, increased purchasing power of consumers, better facilities for transportation (including refrigeration) and to the emphasis given to the value of vegetables in the diet. Fairly recent reports indicate that with the exception of green peas, vegetables are consumed in larger quantities from the fresh state than from cans. Furthermore, fresh-frozen peas and lima beans are competing successfully on the markets with the canned products and also with fresh peas, and lima beans.

Some of the vegetables of outstanding commercial importance and valued highly for home production and consumption are white potato, sweet potato, asparagus, bean, cabbage, carrot, cauliflower, sweet corn, peas, pepper, horse-radish, parsnip, radish, spinach, lettuce, squash, turnip, onion, celery, pumpkin, cantaloupe and watermelon.

The tremendous growth and expansion of the vegetable industry during the past three decades may be evidence that vegetable production is likely to become even more important and profitable in the future. A few of the factors that may help to bring this about are the introduction and use of better varieties; markedly improved insect and disease control methods; the employment of labor saving machinery; the adoption of superior handling and marketing practices; and through research the discovery of more economical methods of irrigation and soil improvement.

VEGETABLE GROWING SECTIONS

Vegetables are grown for home use and for sale throughout the United States. Their value amounts to nearly 800 to 900 million dollars annually. The only crop grown in this country that has a greater value than vegetables is cotton. For the production of 21 of the important vegetable crops exclusive of potatoes and sweet potatoes the following states are listed: California, Florida, New York, New Jersey, Texas, Maryland, Michigan, and Indiana. Still others leading in potato production in addition to being notable for vegetable growing are Maine, New York, Pennsylvania, Wisconsin, Idaho, and Colorado.

KINDS OF VEGETABLE PRODUCTION

Vegetable production is usually divided into six more or less standard forms or types. These are: Home gardening, market gardening, vegetable forcing, truck farming, canning crops, and seed growing. Two or more of these different kinds of vegetable production may be practiced on the same farm. In fact, clear distinction may be difficult to make between the types concerned. For example, vegetable forcing and market gardening are often developed as a single production project. Likewise, some producers combine truck farming with the production of canning crops. Still others in the far west may grow on the same ranch, truck crops and vegetable seeds.

HOME GARDENING.—Perhaps there is no other phase or type of vegetable gardening more important than home gardening. Whether the family

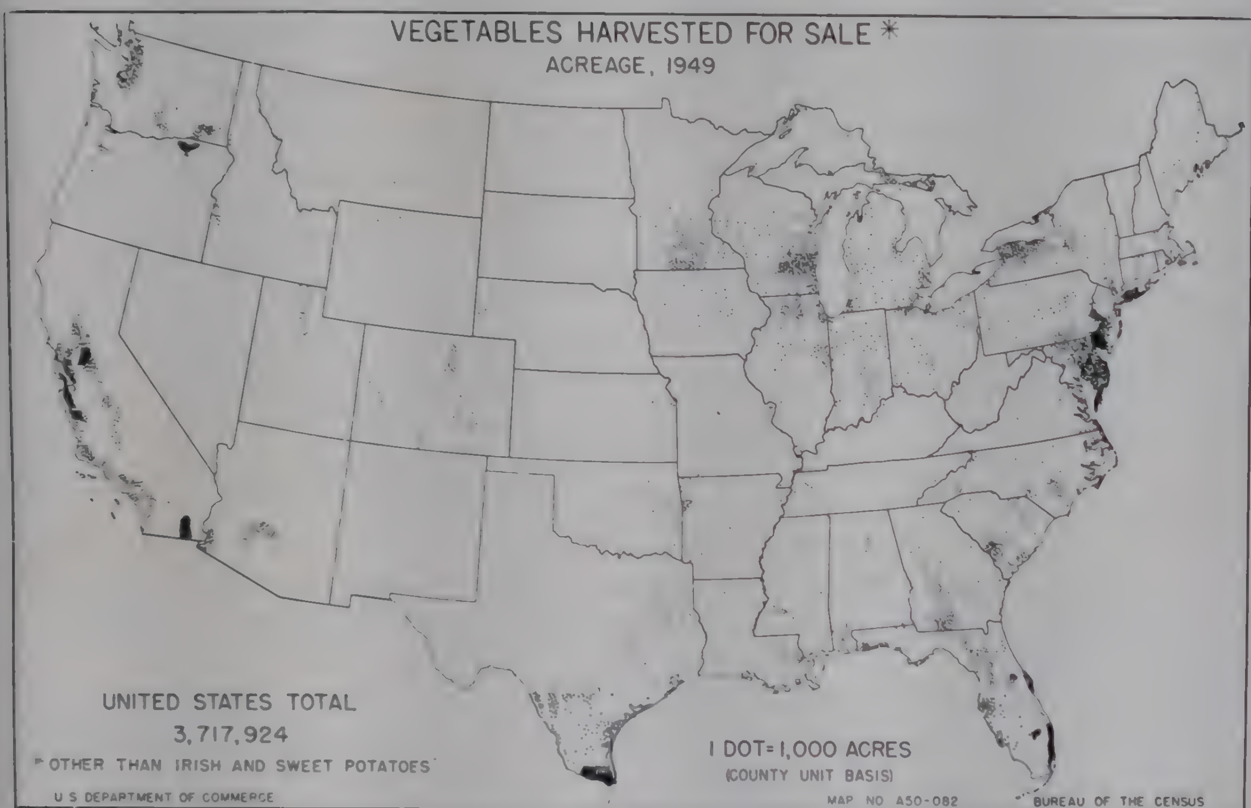

FIG. 43

lives in the country, town or city, if garden space is available, all may be benefited and made happier by growing a good home vegetable garden. It is one project in which all the members of the family may unite for the common good.

Healthful outdoor exercise and profitable recreation may be obtained in seeding, planting, hoeing, thinning, fertilizing, irrigating and the like. Then, there are the joys and thrills that stimulate the gardener. Tiny seeds sprout, push up through the soil and develop rapidly into robust, luxuriant vegetable crops. And they may come directly from the back yard garden to the kitchen. When harvested at the peak of maturity most all of the crispness, delicate flavors, aromas and freshness are retained.

The garden can be made to supply an adequate quantity of fresh vegetables from early spring until late autumn, and in addition, all that may be required for canning, preserving, and storing for winter use. Intelligently planned and carried out, the home garden becomes a source of education and inspiration instead of drudgery and disappointment. Furthermore, it may become an effective means of making substantial savings in the monthly family budget.

Market Gardening.—The object or purpose is to produce an assortment or quantity of vegetables for selling on the local or home markets. Although this type of gardening is still expanding and developing, producers have been required to change their methods and practices to meet competition from distant producing sections. Better highway and railway transportation methods and facilities were chiefly responsible for this change. Transportation by air is now possible and further expansion and development is certain. Market gardeners are preparing however, to make additional adjustments to meet local market needs and demands.

Vegetable Forcing.—This type consists of producing vegetables out of their normal season. It is brought about by protecting the vegetable crops from cold. Toward the North, greenhouses are generally used, while in the central and southern areas hotbeds, cold frames, and other structures may be employed. A strong demand and the high purchasing power of consumers have favored vegetable forcing in order to supply the markets with fresh vegetables the year around. Lettuce, tomatoes and cucumbers are the crops most often used for forcing. The North Central and Northeastern states make up the main producing areas.

Truck Farming.—Truck farming on the whole is considerably more extensive and specialized than market gardening. The areas or districts of production have been selected generally on account of superior soils and favorable climatic conditions for the growing of special crops. Naturally vegetables may be grown on a large scale and at a considerable distance from the markets.

In recent years truck farming has shown the most rapid growth. This has been particularly true in the West and South. In theory, the truck farmer has the whole country in mind as a market rather than a particular outlet. It is dependent upon satisfactory transportation facilities as the heavy and extensive production generally requires both car lot and automobile truck shipments.

A series of truck farming districts exist in the different parts of the country. A typical example is the one extending along the Atlantic coast from southern Florida to New York. In general about the same crops are produced but the harvesting or maturity period begins in Florida and becomes later toward the north. A succession of shipping seasons is established which tends to prevent destructive competition and unsatisfactory markets in the different trucking areas.

Canning Crops. The most important canning crops are tomatoes, sweet corn, asparagus, beans, peas, spinach, and beets. Canned vegetables have increased tremendously in recent years. The northern states and California lead in the production of canned vegetables. Like truck crops, canning crops are usually produced on a rather extensive scale. Areas of

low cost of production and cheap labor have been developed in some instances. The crops are often grown under contract. Definite acreages may be planted and the harvest is delivered to the canner at a set price subject to grade and quality. Returns to growers may not be high, but when large yields can be produced at low costs canning crops may prove profitable.

SEED GROWING.—Most of the vegetable seeds used are now grown in the United States. The seed business has become highly specialized. The different lines include wholesalers, retailers, seed breeders, specialty growers, contract growers, and others. Production is practiced in regions where climatic conditions are favorable for good seed production, ripening and curing. Most vegetable producers do not save seed as formerly because better results are usually obtained through purchase from reliable seedsmen. A good working knowledge, however, of seed production and handling, should be of value to all producers.

For profitable returns in seed growing large yields are required of high quality. It is equally important that the seed be well-cured and that production cost be kept to the minimum. The dry climates of the irrigated districts of western United States have been found to be very satisfactory for seed production.

Some of the chief seed producing districts are Puget Sound and Vancouver Island for cabbage, spinach and beet seed; for snap beans, Idaho, Montana and California; for garden peas, the elevated areas of Washington, Montana, Idaho, and Wyoming; for lettuce, Santa Clara Valley and Delta of California; and for cucumbers and cantaloupes, the Colorado River Valley.

STORING WATER IN SOIL

The University of Missouri Soils Department believes that the possibility of "holding rain where it falls," or storing water in the soil deserves careful consideration. It is often assumed that by using the soil as a reservoir it will eliminate the need for large reservoirs in river valleys to prevent floods. Storing water in the soil has a strong appeal to many who do not understand the problems involved.

An estimate of the amount of water that can be stored is important. Soils differ greatly in their capacity. Some will absorb an inch of water, others will take up to three or four times that amount. Storing water in the soil requires conditions favorable to rapid infiltration during the rain. Usually a recently tilled soil is the most absorptive. However, land should not be left without cover. A dense cover, particularly grass sod, is probably the most effective method of increasing infiltration.

A forest cover is favorable to water infiltration, but an increase in forest area is not likely to occur. Major floods occur after prolonged rainy periods and after the soils have become saturated. When additional rains come high runoff may be anticipated. Storing more water in the soil, therefore, under certain conditions, may even be favorable to the occurrence of floods.

Water storage in the soil is possible only when the soil is dry. Approximately 30 per cent of the total annual rainfall for some sections is lost as runoff. If only 50 per cent of this loss were added to the soil, it might frequently cause a saturated condition. It should be noted that most runoff results from heavy rains and when the soil is normally wet or saturated.

FIG. 44.—This is "trash mulch" cultivation. It enables more moisture to enter the soil and decreases evaporation from the soil surface. A special tillage implement is working the soil beneath the mulch, in order that crops may be seeded or transplanted and still leave a mulch on the soil surface. The implement and practice are particularly well suited to the culture of both fruit and vegetable crops. (Mo. Agr. Exp. Sta.)

The effect on crops and on the soil itself, that may result from increasing the water supply in the soil, is rarely considered. This effect may be disastrous. When the soil remains wet for prolonged periods, aeration is reduced, bacterial activity is retarded, there is increased leaching of soil nutrients, plant roots are shallower, the quality of the crops is inferior and soil erosion is increased.

In brief, soil deterioration is intensified. This is evidenced by the generally lower productivity of soils subject to intermittent wet conditions. The higher fertility of the soils in the low rainfall or sub-humid regions is attributed to good aeration and slight leaching. To increase the water in soils that have a claypan or slowly permeable subsoil, would at times make these soils unfit for the production of cultivated crops. The loss in crops, due to wet soils, may be vastly greater than the total loss of crops resulting from flood. Obviously, storing water in the, soil important as it appears, has serious limitations and its effect on reducing floods is uncertain.

PERENNIAL VEGETABLES

Asparagus, Rhubarb, Globe Artichoke, Jerusalem Artichoke, and Horseradish

The growing of perennial crops differs from that of other vegetable crops due to the fact that they may occupy the ground for a number of years. An area of soil, therefore, is usually alloted to them on a more or less permanent basis. It is also important that the location selected be one where they will not interfere with the cultural operations for other crops.

Fig. 45.—Asparagus crowns or plants set in a trench ready for covering with soil. (Photo by Bureau of Plant Industry, Soils and Agricultural Engineering, U.S.D.A.)

ASPARAGUS
(*Asparagus officinalis*)

This perennial crop is hardy in practically all sections of the United States. Strong 1-or 2-year-old crowns are preferred for planting rather than to use seeds for starting plants. Crowns are set in early spring in furrows 6 to 8 inches deep. In the row, they are placed $1\frac{1}{2}$ to 2 feet apart in rows 3 to 4 feet apart. The roots are covered with soil to a depth of about 3 inches and as the plants grow additional soil is gradually worked into the furrows at the cultivation periods until the land is level.

Asparagus should not be cut the first year as the following season's crop is dependent upon good vigorous crowns and roots. Good cultivation should be given all summer, and the tops cut away and removed from the bed after they mature in late fall. Soil should be given a good fall working to a depth of about 4 inches. Then an application of a few inches of strawy manure may prove helpful. In the spring start cultivation early, covering the whole surface, and put on a good mulch of well rotted manure. Do not cultivate deep enough to injure the crowns.

If the plants made a good growth the first year, a light cutting may be made the second season but a heavy cutting can not be expected until the third year. The bed should be kept free from weeds by cultivation and hand working. In the third spring, cutting may be started as soon as stalks are 6 to 8 inches high and may be continued until midsummer. Everything should be kept cut as long as the cutting season is continued regardless of size. New "fingers" or stalks coming up from the crown may be damaged unless care is exercised in cutting to prevent injury to the tips of the young stalks.

FIG. 46.—Asparagus shoots ready to be cut with a useful implement (Photo by Bureau of Plant Industry, Soils, and Agricultural Engineering, U.S.D.A.)

Regular asparagus knives are available for cutting but any thin, narrow-bladed knife can be used. After the cutting season the bed should be well cultivated to insure good top growth of strong crowns that will grow large sprouts the next spring. In many localities where it is dry in midsummer, irrigation at that time is very beneficial. A mulch of strawy manure, put on the ground late in the fall and removed or worked into the soil after growth starts in the spring, may be advisable.

VARIETIES.—The standard variety at this time is Martha Washington. Branching out of the variety does not occur until the spears are of market length. This characteristic combined with marked resistance to rust makes the variety superior to all others. The Martha Washington variety ranks high, however, and is usually commended by growers.

SITE AND SOILS. As asparagus is a long-lived crop it is wise to select a site that is likely to prove suitable for as long as 15 years or more. Protection from wind sufficient to prevent the stalks from blowing over is desirable. Crooked spikes may develop from one day of strong winds during the cutting season.

Light soil types including sandly loams warm early and hasten early production of sprouts. However, the plants are not as long-lived as on heavier, deeper, and richer soils. For good results it is essential that the soil be kept loose and friable to allow the spears to grow straight in pushing up through the ground. Heavy soils warm slowly and are usually more difficult to handle than light soils.

If possible, soil preparation for planting should start a year or more before setting. Asparagus is a heavy feeder and a fertile soil is needed. On most patches and fields manure may be added to advantage each year and supplemented profitably with a commercial nitrogen fertilizer. In fact, the fertilizer may be applied with best results, using half the amount before the cutting season and half when the harvest is finished.

It should be understood that asparagus plants can take up and use fertilizers in the spring before there is any top growth. If maturity occurs early in the fall or the tops turn yellow in color, nitrogen is usually needed. When applied early the next spring, the growth of spears are stimulated. From 600 to 800 pounds per acre of a complete fertilizer is often applied to fields and beds or nitrogen alone in equal amount may be needed.

Disease and Insect Control.—Asparagus rust is the serious disease of this plant. It attacks the tall stalks that grow after cutting and prevents proper food storage for the next spring's "spears" or shoots. It occurs in the form of orange or black pustules or blisters on the foliage. Spraying is ineffective and the only remedy lies in prevention through the selection of resistant varieties.

Asparagus beetles are the chief insect enemy. They are about one-fourth of an inch long, red, black, and yellow in color. Larvæ, or grubs, and adults feed on the foliage and may damage the cutting parts. Use emulsified rotenone concentrate as directed on the container. Treat when needed to keep insects off spears or foliage. Apply rotenone during the cutting season if needed.

RHUBARB

(*Rheum rhaponticum*)

Rhubarb, often referred to as "pie plant" is one of our most important perennial vegetable crops. It is primarily a cool-season plant, and is available very early in the spring when the supply of many other vegetables is limited. For the home garden where only a few plants are needed to supply the family, rhubarb should be placed to one side of the garden with such perennial crops as asparagus, horseradish, and kale.

Rhubarb is not particular as to soil type, but may be grown on any fertile well drained soil. Since it is considered one of the strongest feeders it should have plenty of moisture and heavy application of barnyard manure. Manure is usually applied in the fall or winter and worked into the soil the following spring.

The most common method of propagation is by division of the root clumps. Roots may be cut into as many divisions as there are healthy eyes or buds. Each division must have at least one eye, but it is better to have two or three buds to each division. Only strong growing plants

from fields known to be free from disease should be used in new plantings.

The roots are usually planted early in the spring in rows 4 to 6 feet apart and from 3 to 5 feet apart in the row, depending on the variety used. After opening a furrow the rhubarb roots are spread out and the crown covered with not more than 3 inches of soil. Clean cultivation to keep down weeds and maintain a soil mulch generally gives best yields.

For best results the newly planted rhubarb roots should be allowed to grow for two seasons before any crop is harvested. For the third year the harvest period, depending on the growth that has been made, should not extend over 4 weeks. Beginning with the fourth year the harvest season may be lengthened to from 8 to 10 weeks. In harvesting the stalks are pulled, not cut nor broken off, above the surface of the ground. The stubs of stalks left after cutting or breaking serve as possible sources of infections for the crown rot organisms, which are doing considerable damage in both commercial fields and home gardens. After the cutting season, seed stalks growing up from the center of the crown will make their appearance. These should be removed since they are using plant food which should be stored in the roots for early growth the following spring.

Commercial culture is most abundant in the northern areas where the summers are cool and moist and the winters are cold enough to freeze the ground to a depth of at least 3 to 4 inches. The maximum development of the leaf stalks and red color occurs during cool temperatures of the growing season. Rhubarb is dormant during the winter in cold areas and produces best in cool weather of early spring. With plenty of moisture, however, production may be continued in summer. For areas with dry summers and mild winters, the plant is dormant in summer and makes its best growth in winter and early spring.

VARIETIES.—The old standard sorts are Victoria and Linnaeus. Most commercial and home plantings still consist of these varieties. However, those making a careful study of varieties believe that some of the Canadian introductions have great promise and may soon replace the standard varieties. Among the most worthy of these new sorts are MacDoland, Valentine, Ruby, and Early Sunrise. Still other varieties consist of Mammoth Red, Early Arizona, Hobday Giant, Sutton's Seedless, Wagner Giant, Riverside Giant, and Strawberry. The term "Strawberry" may refer to a particular type instead of a distinct variety.

GLOBE ARTICHOKE

(*Cynara scolymus*)

In Europe this vegetable is given a prominent place in the diet. However, commercial production in America is confined to a few coastal counties in California, usually within a few miles of the ocean. The immature flower head is the edible portion. In Louisiana, the Creole type is produced. For this kind the scales or buds point outward while for the type in California they fold inward as is true for the leaves of the cabbage head.

The globe artichoke is not hardy in the northern states but it may be grown in some sections where good protection against cold is afforded. Suckers are used in propagation and they are set 6 to 8 inches deep, and spaced 4 to 6 feet apart. Fall and early winter planting in mild climates give the best results.

About every two or three years the planting should be renewed. A friable fertile soil is desirable. After transplanting in early spring, in California, a small crop of buds may be harvested. The markets prefer large buds. Following the picking season, the plants are allowed to dry after which they are cut just below the ground surface. The tops may be fed to dairy cattle in the form of ensilage or plowed under in the field.

VARIETIES.—The most important variety is the Large Green Globe. Purple Globe is another variety producing smaller buds with purple colored outer bracts.

JERUSALEM ARTICHOKE

(*Helianthus tuberosus*)

The Jerusalem artichoke, as it is commonly known, is grown for the underground potato-like tubers. It is a perennial plant and once started takes care of itself. It is grown from tubers planted like potatoes. It is produced to a very limited extent for food but is used quite extensively in some sections for stock feed, particularly for hogs. Swine will root for the tubers or the soil can be plowed and the tubers exposed to them.

It is native to the northern part of the United States and to parts of Canada. Although the edible tubers are rated as equal to the potato in nutritive value, the taste is not acceptable to most people. The tubers are valued highly for stock food. Hogs are frequently used in harvesting the crop.

Although the vegetable may yield well on poor ground, it will respond favorably to good soils and liberal fertilization. Sandy loams are preferred. Under good conditions, the plants may produce 500 to 1000 bushels an acre. Whole tubers may be planted or they may be cut into 1 to 3 eye pieces like potatoes and prepared for planting. The rows are usually made about 3 feet apart and the tubers or cut pieces are planted about 15 to 18 inches apart in the rows. When the tops die down toward the end of the season the crop may be harvested. Furthermore, the tubers may be left in the soil over winter without danger of injury from freezing.

HORSERADISH

(*Armoracia rusticana*)

Horseradish is grown in many home gardens where it is often allowed to develop as an uncultivated perennial root crop. It is, however, a highly specialized vegetable crop as grown in the commercial section of St. Louis county, Missouri and elsewhere. A relish made from the grated roots is very popular.

A deep, fertile, mellow, well-drained soil is essential for the profitable production of horseradish. It is propagated from root pieces called "sets." These are usually cut into lengths of about 12 to 14 inches and about one-half inch in diameter. In the commercial districts the "sets" are planted in shallow furrows in a slanting position, with the upper end of the "sets" within 1 or 2 inches of the surface of the soil when covered.

The "sets" are placed 18 inches apart in the row and from 30 to 36 inches between rows. The crop of roots can be stored in a pit or a root cellar. In either method of storage, ventilation is necessary or heating will result. When grown as a garden crop the roots may be left in the ground and dug as needed. For the home garden a 10-foot row of horse-radish should produce an abundance for the average family.

Fig. 47.—Contour farming. This practice has spread rapidly throughout the United States, on account of saving soils and soil fertility. (Mo. Soil Conservation Service.)

SWEET CORN

(*Zea mays* var. *rugosa*)

Sweet corn is the type or kind adapted to growing in home gardens or for commercial purposes. Perhaps there is no greater favorite of the garden than sweet corn. It should be harvested for consumption as soon as it reaches the milk stage. Moreover, it should be fresh as possible to have the best flavor. The shorter the time between the ear on the stalk and the time it reaches the table, the sweeter and more palatable the corn. The product loses its delicate and delicious taste rapidly after picking. Successive plantings of the same kind or planting early, medium and late varieties are required to obtain a continuous supply. For good results, sweet corn should be planted on rich land and given proper, clean cultivation. It may be planted in drills and thinned to 8 or 12 inches apart.

American Origin.—Sweet corn is of American origin and it is of great commercial importance. The crop is generally grown throughout the

country and the local and commercial markets are supplied from July until cold weather occurs. For canning and processing purposes, it is grown extensively in favorable sections of the United States. With the improvement of varieties, the adoption of better methods including speedier transportation and the utilization of refrigeration, consumption is rapidly increasing.

Maturity Influences.—The different growing areas and seasons may have a marked influence on the maturity of sweet corn. In fact, a particular variety may mature from 2 to 3 weeks later in some areas than in others. While the length of the frost free season is important yet it is not as significant for corn as for many other vegetable crops because the corn is harvested before maturity. Hot summer weather and an abundance of bright sunlight are needed for the highest development. However, when the harvest stage is reached somewhat cooler weather is helpful. Ripening under cool conditions retards the loss of sugars by respiration in the corn kernels, while warm temperatures hastens these changes.

Soil Types.—Sweet corn may succeed on many different soil types suitable for the growing of field and truck crops. Toward the northern areas, a warm soil containing considerable sand is preferred in producing crops for the early markets. Well drained aerated muck soils may grow satisfactory crops. In fertilizing the soil for good production, previous cropping, type of soil, and its natural fertility should be taken into consideration. Manure is often used at the rate of from 5 to 10 tons per acre supplemented by applications of a complete fertilizer applied at the rate of about 300 to 600 pounds per acre depending upon the need.

Planting.—Plantings may be made in rows spaced $2\frac{1}{2}$ to $3\frac{1}{2}$ feet apart with the seed sowed in the rows and covered to a depth of 1 to $1\frac{1}{2}$ inches. If the corn kernels can be distributed at time of planting to give a stand of plants about 9 to 12 inches apart, the work of corn plant thinning may be reduced materially. It is worthwhile to note that in early seeding, the kernels should be covered rather lightly with soil while in later plantings the soil covering may be a little deeper. Seed sown early and covered too deeply, (at greater depths than 1 to $1\frac{1}{2}$ inches) may rot especially if cool rainy weather prevails before seed germination occurs.

Sucker Removal.—Experiments and observations have now shown that the removal of suckers a foot or more long tends to reduce rather than to increase yields. Suckering practices have in general, therefore, been discontinued. Tests made at several stations on removing suckers at different periods and by different methods have convinced the researchers that no profitable benefits in earliness, size of ear or total yield occurs from suckering.

Shallow cultivations to check weed growth and aerate the soil is advised to stimulate strong, healthy plant growth. After growth begins and while the corn plants range in height from a few inches to as much as 12 to 30 inches tall the soil between the rows is cultivated soon after rains and each irrigation. For good yields and high quality this is essential particularly where the soil types bake or form a hard crust.

For the highest quality the ears are harvested in the milk stage, while containing plenty of juice and at the same time adequate ear firmness and

plumpness and while the silks are medium dry. The ears should be filled out to the tip, the husk tight and the point of the tip blunt.

RIGHT PICKING STAGE.—Experienced growers usually have little difficulty in determining the right picking stage. The feel of the ear when grasped, the appearance of the silk or its dryness and other observations give them ripening clues. It is usually necessary for inexperienced growers to spread the husk slightly and examine the kernels. The so-called thumbnail test may be required. This consists of thrusting the thumbnail into the kernels. The exudation of milk indicates that the corn is in the proper or milk stage; while if dough is forced out of the kernels, the corn is too ripe to be of highest quality.

VARIETIES.—Since great differences may occur among strains within a variety, growers should know that the variety planted has proven satisfactory under similar soil and seasonal conditions. The yellow sweet corn variety known as Golden Bantam has long been considered the leader in excellence in open-pollinated corn of this type. Many strains are available but the true one is 8-rowed. In sections where Golden Bantam is too late, such varieties as Banting, Golden Early Market, and Golden Early Sweet may be obtained. Still later varieties consisting of Stowell Evergreen, Country Gentleman, and Howling Mob are available. In most cases, however, hybrids have assumed the greatest importance. The state agricultural experiment stations should be consulted for the best information on the hybrids best suited for planting in each state.

POP CORN

This crop requires the same conditions as sweet corn. Successive plantings are not necessary but varieties should be chosen that will mature. The crop is grown for use after it is dry. That it be properly cured—dry enough, yet not over cured—is very important for best results in popping. Varieties differ a great deal in size of plant, but spacing the same as sweet corn will be satisfactory. If space is not a vital question a little pop corn grown in the garden will give means for a lot of pleasure during winter evenings. If garden space is at a premium probably the land better be used for some of the more staple vegetables, and a supply of pop corn purchased. Certainly the farm garden should provide for home-grown pop corn. White Rice and Japanese White Rice are popular varieties and Yellow Pearl, Supergold, Superb and Tom Thumb are good yellow sorts.

DISEASES AND INSECTS.—Corn is subject to many diseases and several insect troubles. These are worse in some places than others. In general, if good seed is used and the garden is properly cared for, diseases and insects will not be of serious importance. Corn smut may show up in the garden and can be identified by its appearance, which is designated by the name. By removing and destroying all smut infected parts as soon as noticeable, the disease can be pretty well kept in check. Rotating from one part of the garden to another will help.

Corn ear worms are serious pests wherever they are present in numbers. The damage is done by caterpillars or larvæ, $1\frac{1}{2}$ to 2 inches long. They vary from green to brown in color, with quite variable markings. Eggs

are laid on the silk. When the eggs hatch young worms work down under the husks where they do their damage by feeding on the silks and green kernels. Late corn is infested worst.

The European corn borer is a corn enemy introduced from Europe into the New England states. It has spread to several northeastern, east central and middle western states and promises to be very serious if not checked. The destructive brown headed caterpillar is about $\frac{3}{4}$ inch long. It bores into the stalks, ears, cob, and tassel. The number of broods depends upon the climate. Strict federal and state quarantines are maintained in an effort to prevent its spread. Destruction of infected plants and a general cleaning up are advised. The superiority of the hybrid sorts is shown in the increased yields, standing ability, and popping expansion. Consult the state agricultural experiment stations for the latest information. Furthermore, at the close of Chapter 24 will be found a chart containing dust and spray schedules for the control of vegetable crop insects.

Fig. 48.—Sprinkler irrigation. Note the sharp turn made possible by use of proper coupling without reducing sprinkler flow. (Courtesy of Champion Corporation, Hammond, Ind.)

SPRINKLER IRRIGATION

The type of irrigation now most generally used is the sprinkler system. The water is carried to the garden or field in pipes and under pressure and it is sprayed out through nozzles into the air and falls to the ground in droplets like rainfall. The sprinkler system applies the water at a rate which the soil will immediately absorb. The method differs considerably from surface systems of irrigation in which the water is allowed to run on the soil for general distribution and absorption. While the sprinkler principle has been known for a long time, yet it did not become popular and practical in the humid sections for general uses until about five or six years ago.

Sprinkler Layouts

Sprinkler systems or layouts may be portable, permanent and semi-portable systems. Permanent systems have permanently located pumps,

main lines and laterals for distributing the water. The cost of permanent outfits is generally high and their use is decreasing.

For the portable rotary system, the complete unit may be moved from the rows watered or from plot to plot during the irrigation of a field as the pipes are light and durable. They are the least expensive to install, but they may require more labor for the irrigation work.

Sprinkling Advantages

Soil erosion is prevented through the use of the sprinkler system. The water soaks into the soil as fast as it is applied. Soils too porous for economical surface irrigation may be irrigated successfully by sprinklers. Also, the sprinkler system may use about the same amount of water at the far end of the portable line as at the pump. Good use may also be made of a flow of water that would be too small for wise surface irrigation. Land leveling is not required and steep slopes and irregular land surfaces may be irrigated. Irrigation does not puddle the soil or have a compacting effect on the ground.

Portable sprinkler irrigation has shown great economic value in humid, as well as arid sections. In the East, South, and Middle West particularly, the sprinkler irrigation practices have been found to be profitable methods of supplementing natural rainfall. Even in years of normal rain, crop yields are often increased, and high quality maintained or improved. Most important, however, crops are insured against serious loss in years of drought. Irrigation may go a long way toward removing the risk from production.

With the introduction of aluminum pipe, which weighs approximately one-third as much as steel, sprinkler irrigation has become very practical and useable in all sections of the country. Furthermore, the light weight of the irrigation pipe enables one man to carry two or more 20-foot lengths of 4-inch pipe without difficulty.

The quick-latching flexible couplings, fitted to ends of pipe sections makes it easy and inexpensive to join lengths of pipe in operating from irrigated to non-irrigated crops. Friction loss is low in the pipes because the interior surface is smooth. Less power, therefore, is required to deliver water at a given pressure at the outlets.

Drainage problems and soil waterlogging are not encountered under proper handling. Water can be metered to the field at almost any rate desired. Also, through the use of water of satisfactory quality there is no danger of salt and alkaline deposits on the soil surface.

Disadvantages of Sprinklers

The water used in irrigation is usually under continuous pressure and pumping cost. In more or less arid and windy regions, the spray pattern may be distorted enough to prevent an even distribution of the water. Water evaporation losses may be particularly high in such areas. If surface waters are used it is especially important that all floating trash and material

likely to cause clogging of the sprinkler nozzles be screened out effectively. This may become a very important factor where trashy water and poor screening methods are used, as a part or all of the system may be out of order for indefinite periods.

Surface Irrigation

This type of irrigation is particularly common in the older irrigation regions of the West and Northwest. The land should slope uniformly. The plants are often set on raised beds or rows and the water is applied in the furrow between the beds or rows when the planting operations are completed. The rows should be not more than about 500 feet long and preferably not over 300 feet in order to prevent water losses.

Overhead Irrigation

In this system a uniform supply of water may be applied to the soil. It is used on both uniform and non-uniform soil or slopes and it does not have a packing effect upon the ground. The system lends itself well to the intensive culture of crops including crop rotations with strawberries. Perhaps, the chief objection to the system is that it is relatively expensive. As with the sprinkler system, the water may be turned on during periods of frost damage as the application of the water may give some protection against frost damage.

Canvas Hose Irrigation

This system is used effectively where the slope in general, is fairly uniform. There must also be adequate water pressure. If the rows are about 100 feet long or more, water pressure may become an important problem. The hose is laid on the soil between the rows. Under pressure, the water is turned into one end of the hose. When the hose is filled the water oozes out through the canvas. The water pressure is so arranged that the soil absorbs the moisture as fast as it seeps through small holes in the canvas. Upon the completion of the irrigation of one row, the hose is moved to the next and the work is continued in this manner until the task is finished. The method allows the fruit and foliage of the plants to remain dry while the irrigation operation is in progress.

Caution

Vegetable and fruit growers interested in irrigation should make a careful study and investigation of their needs and requirements before making purchases of equipment. Good sources of information are Agricultural Experiment Stations, Soil Conservation Service, County Agricultural Agents, Teachers of Vocational Agriculture and other Government and State employees.

Much dependsupon local conditions. For this reason, the grower should get the proper answers that apply to his own particular requirements from those best qualified to study his needs and offer good suggestions for the establishment of an efficient irrigation project.

While the portable sprinkler irrigation system is not very complicated or difficult, yet for the best results and assured satisfaction, competent advice and assistance on instillation is of paramount importance. This is true because failures and disappointments are practically eliminated if sound advice on buying equipment and installation is followed.

Chapter 18

Root, Legume and Bulb Crops

ROOT CROPS

CARROT

(*Daucus carota*)

The carrot is much more widely grown in Europe than in the United States. Its lack of popularity in this country may be partly due to insufficient information regarding the best methods of preparation for table use. However, its high vitamin and mineral content have been firmly established and rapid increases in consumption and production have occurred in recent years. The vegetable is a cool weather crop but it may withstand the summer heat of the North. For the average home garden 2 to 2½ pounds per foot is considered a good yield and the market gardener under satisfactory conditions may produce 500 to 600 bushels per acre. For canneries, the average production is about 20 to 25 tons per acre.

Carrots will grow well over a wide range of different soil types. However, for long rooted varieties a deep and loose soil is desired. Well drained muck soils generally produce excellent crops. Soils in a high state of fertility are best for tender growth. Liberal quantities of organic matter are needed and a fertilizer comparatively high in potash such as a 5-11-10 or 5-8-7 analysis may be found valuable. Applications as high as 1000 to 1500 pounds per acre may be required for good yields.

Carrots are hardy and are relatively easy to grow. For real early use sow the seed as soon as the ground can be worked in the spring and follow by successive plantings to provide young carrots throughout the season. If carrots are allowed to mature and stay in the ground they become woody. Plantings should be made in the summer, the time to be governed by the section in question, to provide plenty of carrots to store for winter use.

Carrot seeds are quite small and difficult to plant without getting them too thick. They should be drilled and later thinned to about 3 inches apart in the row. The thinning should be done before the plants are 6 inches high. Where two thinnings are made, the first, may be to 1½ inch intervals and the final thinning done later when the young, tender carrots are large enough to use. The seed should be covered about ½ inch. Rows for the farm garden should be about 42 inches apart to allow for power or horse cultivation. In small gardens for hand cultivation or under irrigation th rows may be as close as 12 to 14 inches.

VARIETIES. Red Cored Chantenay is popular for canning, general planting and is quite satisfactory for storing. Important bunching varieties are Morse Bunching and Streamliner. Nantes, a so-called "coreless" sort, ranks high in quality. The brittle tops of this variety, however, cause pulling troubles and make bunching less desirable. Still other varieties of merit are Imperator and Danvers.

Generally carrots are not damaged by insects and diseases. The carrot weevil may occasionally do considerable damage. Rotation of crops materially aids in the control of this pest. For carrot leaf-hoppers, use 5% DDT as a dust or spray and start treatment when the plants are about 2 to 3 inches tall. Repeat each week for 4 weeks.

BEETS

(*Beta vulgaris*)

The beet is a very old vegetable and is widely grown in small gardens. The tops of young beets are used as greens when the plants are thinned in the row. Beets can be planted as early in the spring as the ground is suitable for working. Successive sowings should be made every 10 days or two weeks until three or four plantings are in, to insure a continuous supply of tender young beets. Seed should be drilled and covered about ½ inch deep. The seed should not be closer than ½ inch apart in rows 12 to 18 inches apart. Where weather conditions will permit germination of seed in summer, a late planting of beets can be made in July to give a fall crop and furnish the winter supply. Spring sown beets, if harvested late enough to keep in good condition until winter, are apt to be woody.

Since beet seed are slow to germinate, radish seed may be sparsely sown in the row to serve as markers. Cultivation can then be done sooner without the danger of destroying the rows as might result from blind cultivation. Radishes grow quickly and can be pulled for use before the beets are large enough to be bothered. Thinning of the beet plants should start when they are 6 inches high. They can be thinned gradually and the young plants used for greens. The full distance between beets should be 5 or 6 inches. If a fall crop can be grown for the winter supply allow them to remain in the ground as long as possible without danger of freezing.

The crop should be given good cultivation and kept free from weeds. In dry sections one or two irrigations are a wonderful help in securing a good crop. There are several different types and varieties of beets. Some of these are Detroit Dark Red, Early Wonder, Crimson Globe, Ohio Canner, and Winter Keeper.

Beet diseases are few in number and only one is generally serious. This is the beet leaf spot which causes numerous small, irregular dead spots on the leaf tissue. These spots, having a white center and purple border, are caused by a fungus. Leaves of infected plants may curl, dry up and die. Spraying with Bordeaux mixture (4-5-50) when the spots first appear and again in 10 days will control the disease. Crop rotation aids in prevention.

Beet insects are not numerous. The beet flea-beetle, a small black insect, is injurious to table beets. The plant is attacked as soon as it appears above the ground. The larvæ infest chickweed and pigweed, and spreads

from these weeds to the beets. When numerous they destroy plants very quickly. They are controlled by spraying with arsenate of lead when the insect makes its first appearance and repeating sprays when needed. As a means of prevention, keep pigweed, chickweed, and lambs-quarters from growing near the garden as they are native food plants for the flea-beetle.

Beets may be attacked by some of the webworms which web the leaves together and eat the foliage. They can be controlled by spraying early with arsenate of lead and removing pigweed from around the garden.

RADISHES

(*Raphanus sativus*)

Radishes are our quickest maturing vegetable. They have long been a favorite for the home garden and within recent years have become of considerable commercial importance as a field crop in Southeast Missouri and elsewhere. In general a sandy loam is preferred, as this type of soil warms up much quicker in the early spring than the heavier types.

The best spring radishes, for garden or hotbed culture, are the round red sorts. Some recommended varieties are Early Scarlet Globe, Early Scarlet Turnip, Crimson Giant, White Icicle, White Tipped and Saxa.

These varieties are very early and will mature in approximately 30 days from seeding. For the Central States successive plantings of the above sorts should be made from March 10 to May 1. After May 1st it is well to plant such varieties as White Icicle and White Strasburg.

Winter radishes, although not as commonly grown as the early summer types, may be easily produced either for fresh radishes or for storing for winter use. The winter radish may be had in all shapes and colors but the Long Black Spanish and the Rose Chinese are the varieties recommended.

The early radishes may be sown between rows of slower maturing crops. Broadcast in beds or drill in rows 10 to 12 inches apart. The plants are thinned by pulling as they reach edible size. For market the roots are pulled, washed and bunched with the tops on. From the commercial sections they are iced and shipped in crates or baskets to keep them fresh until they reach market. Due to their very short season of growth, very little trouble is usually experienced from diseases or insects. Where the turnip louse becomes troublesome, it can be controlled by dusting with nicotine sulphate and other insecticides.

PARSNIP

(*Pastinaca sativa*)

The parsnip is a biennial. It requires a long growing period for the development of the attractive white and succulent fleshy roots. The fertilizer and soil requirements are similar to those of carrots and beets. However a deep sandy loam soil is considered best for the production and proper development of the parsnip. The seed should be sown early in a well-prepared seed bed. A few radish seed planted with the parsnip seed will

aid in marking the row, since the parsnip is slow to germinate. Seed in rows 15 to 30 inches apart and thin 3 to 5 inches.

Unlike most root crops, the parsnip root is improved by freezing. The roots may be left in the ground and dug as they are needed; however, it will be found more convenient, especially when the soil is frozen, if the roots are harvested and stored in a trench or pit or other cool storage.

The Hollow Crown and Guernsey varieties are suitable for both the home garden and commercial plantings.

TURNIP AND RUTABAGA

(*Brassica Rapa* and *B. Napobrassica*)

Both the turnip and rutabaga are classed as cool season crops because they make their most rapid and satisfactory growth at comparatively cool temperatures. The rutabaga is more resistant to drought and summer heat conditions than the turnip. The crop is grown in Canada more widely both as a commercial product and as a home garden vegetable than in the United States. Shipments to the northern states in one year amounting to as much as 2 million bushels have been made. The rutabaga root at harvest is larger than the turnip. It is denser than the turnip and has a slightly yellow flesh color. In shape it is rounded or elongated and lacks the flatness of the turnip. The flesh is somewhat richer in carotene content. It may be grown as a spring or fall crop. The main planting for livestock is seeded usually in late June or early July.

The turnip matures in about 45 to 70 days and the rutabaga requires 90 to 100 days. Early maturing types of turnips are grown as a spring crop. Later developing sorts and the rutabagas reach the harvesting stage just ahead of freezing weather in autumn. The turnip in hot weather and when grown slowly may become woody, stringy and bitter.

Rapid, tender growth is the objective of most producers. These goals may be obtained with least difficulty and expense on deep, mellow and fertile loams. Depleted and low fertility soils may need about 600 to 800 pounds of a 4-12-4 or 5-10-5 commercial fertilizer per acre for good yields and high quality.

Early turnips may be seeded as soon as the ground is suitable for working in the spring. The rows may be made from 12 to 18 inches apart. When thinned the plants are left standing about 3 inches apart. Fall crops are usually thinned to greater distances between the plants. For the central and southern states turnips are generally seeded broadcast on well prepared, fertile soils. Under good growing conditions abundant crops suitable for home uses, commercial markets, and stock food may be produced without further attention. Fall turnips are usually planted later in the summer than rutabagas. If rutabagas of large size are desired the plants should be spaced about 8 inches apart in rows 14-18 inches apart.

VARIETIES.—Varieties of turnips used extensively for early crops are Purple Milan and White Milan. Purple Top White Globe, White Egg and Golden Ball are usually satisfactory for fall harvests. For greens and salads Seven-Top is used as it produces an abundance of foliage. Yields of as

much as 500 to 1000 bushels per acre are possible. A popular rutabaga variety is yellow-fleshed American Purple Top.

CELERIAC

(*Apium graveolens var. rapaceum*)

Celeriac is a turnip-rooted celery, which is grown to a very limited extent and used mostly for the flavoring of soups and other vegetables. The crop is handled in much the same manner as celery, except blanching is not practiced. The roots will withstand considerable freezing; however, for best results they should be harvested before hard freezing and stored in a root cellar, trench, or pit. The cultural methods of celery apply equally well to this crop. As blanching is not required, celeriac may be planted in rows 18 to 24 inches apart. When the growing roots have attained a diameter of 2 to 2½ inches the plants may be pulled. Celeriac may be stored in a manner adapted to other root crops. Yields per acre may range from 200 to 300 bushels.

PARSLEY

(*Petroselinum hortense*)

Parsley, one of the most important garden herbs, is grown in most home gardens for use in flavoring and garnishing. A fertile soil with an abundant supply of organic matter and plenty of moisture is desirable. The crop may be grown without difficulty although the seed may be slow to germinate and the plants are delicate. The seed should be planted very early in the spring in rows 12 to 14 inches apart, later thinning the plants to stand about 4 inches apart in the row. Plants may also be started under glass and later transplanted to the field. They should be transplanted quite young or before the taproot becomes too long. Plants will continue to produce leaves throughout the summer and fall. Parsley can be successfully grown in a hotbed or cool greenhouse through the winter months. There are two types, the curled and the plain-leaved. The varieties most grown are the Moss Curled, Double Curled, and Hamburg.

LEGUME OR PULSE CROPS, PEAS

(*Pisum sativum*)

Perhaps no other vegetable in the cool temperate region is as widely grown as the pea. It may be found an important crop in both home and commercial plantings. Furthermore, the pea as a canning vegetable has a ranking along with sweet corn and tomatoes. Large quantities of peas are preserved by refrigeration and marketed as a frozen product.

Cool conditions for growth and maturity generally favor higher yields and better quality. This being true, peas should be planted as soon as soils and weather conditions permit in the early spring. When dry hot weather begins the crop does not thrive. At temperatures considerably lower than for other vegetables, pea seed may germinate splendidly and the

plants produce a vigorous and satisfactory growth. A soil giving a highly acid reaction is not well suited for good pea production.

Soil fertility and texture may be improved profitably for growing peas by plowing under clover and other green manure crops. Commercial producers may utilize the vines as silage to be fed to livestock and salvage the manure for soil building. The roots of the pea plant "fix" nitrogen from the soil air and thus help in the improvement of the land. Frequently the best yields occur when peas follow a cultivated crop. As an abundant supply of avilable potassium generally increases yields markedly, peas are often termed "potash-loving" plants.

Too much emphasis cannot be placed on the matter of thorough seedbed preparation. Experiments and demonstrations supply abundant proof of the value of working the soil into a fine tilth before seeding. Poor stands usually result from the use of seed that shows less than 90 per cent germination. For all varieties seeding is best done as early as the soil is workable. In general, the most satisfactory depth of seeding is about 1½ inches. Seeding much deeper may cause poor stands. The usual rates of seeding are 3½ to 4½ bushels per acre of the Alaska variety. Wrinkled varieties may require for good stands 4 to 4½ bushels. Injury usually results when a fertilizer is used in a grain drill with the seed.

In growing peas for the cannery and the markets, vine supports are not used extensively. Commercial producers have found that the labor and expense involved for supports are not justified. Therefore, comparatively few market growers and large producers make use of supports. The labor item and expense for vine supports may not be too important for the home gardener. Supports may assist in weed control, give increased pickings, supply good exposure and reduce damage to the vines in harvesting.

Peas for canning and market uses are drilled in rows close together and cultivation is not practiced. This being true, good producers have found that the thorough preparation of the seed bed is essential for high yields. Where the peas are grown in rows spaced far enough apart for tillage, 18-24 inches or 24 to 36 inches, timely shallow cultivations made often enough to keep down weeds and grass are advised. The cultivations may be continued until the vines interfere materially.

Varieties.—Alaska, a popular smooth variety, is being replaced in some districts by Surprise for canning. Wrinkled peas, being sweeter than smooth peas, are often preferred for home and market. Good early varieties that mature in about 60 days are Little Marvel, Laxton's Progress, and Laxtonian. Midseason varieties consist of Giant, Wyoming, Wonder, Morse Market and Stridah. Dwarf late sorts are Stratagem and Dwarf Alderman. As much as 70 days may be required for edible maturity of the late varieties.

Insects and Diseases.—Aphids may cause considerable damage in some seasons but may usually be controlled effectively by spraying with Lindane or nicotine sulphate according to directions given on the packages or containers. The pea weevil may also be a damaging pest at times. A 3 to 5 per cent DDT dust thoroughly applied just before the pods set or the use of a ¾ to 1 per cent rotenone dust at this period may give satisfactory control.

A disease known as *root rot* may be damaging. The treatment of seed with red oxide of copper for damping off may be helpful. Crop rotations, good soil drainage and adequate fertilization are always good practices. The *pea blight* and *fusarium wilt* are other diseases that may prove troublesome. However, the good cultural practices suggested above should prove helpful in effecting control.

FIG. 49.—Fordhook No. 242 bush lima beans are vigorous, productive, and heat resistant. (Photo by Bureau of Plant Industry, Soils, and Agricultural Engineering, U.S.D.A.).

BEANS

(Phaseolus vulgaris)

The cultivation of the Broad bean dates from prehistoric times. Both the common and pole lima beans were grown in the New World prior to

1492. In fact, it is well known that the bean was cultivated for food by ancient peoples such as the Romans, Greeks, Egyptians, Hebrews and perhaps by other nations. Beans are well known as a warm season crop and the seed should not be planted until danger of frost is past.

Beans have been divided into many groups and classes. Perhaps the simplest designation for most practical purposes are *field* and *garden* beans. Each of these two groups may in turn be divided into bush and pole beans. Field type bush beans are also recognized or known as kidney, marrow and pea beans and these are subdivided into groups designated as colored and white. Likewise the garden beans may be divided into similar groups and types.

Perhaps it is more important to know that all the classes of beans are grown widely for commercial purposes. Furthermore, the home garden is not complete without each class. In the southern and Atlantic Coast regions snap beans are grown chiefly for the northern markets and they may be grown locally for home uses, roadside markets and other outlets. California, Michigan and New York produce large quantities of dried beans. The production from other states such as Idaho, Washington and Oregon are also significant. Dried beans for commerce consist mainly of the small type. The production of beans for canning and for the dry bean industry constitutes an important business in the United States.

Beans are handled in commerce and used as "dry," "greenshelled" or "snap" depending upon the stage of growth or development at which they were harvested. Different varieties are provided for the various uses. In the home garden the snap beans are most important, while for commercial uses varieties suitable as dried and processed products are desired.

Factors Favoring Production.—It is especially important in some of the western districts that facilities for irrigation be available or that the annual rainfall be sufficient each year for the production of a crop. Equally important or essential is that approximately 120 days of a frost-free growing season be assured. Still other factors involved that may require investigation and attention are the amount of moisture available in the soil at planting time, cultural and harvesting methods employed in growing the crops and harvesting them. Also, the presence and maintenance of nodule-forming bacteria in the soil is worthwhile and of value.

Soil and Fertility.—Practically all types of soils may grow beans successfully. Light loams are satisfactory for early crops but soils somewhat heavier and more retentive of moisture may be better suited to crops that are grown during the summer. Beans in a crop rotation with alsike clover, alfalfa or sweet clover generally prove satisfactory. A loose friable seedbed is desirable. Soils that crust and cake badly are unsuited to the crop as they may prevent the plants from pushing through the soil.

Part of a fairly liberal application of a complete fertilizer may be applied to the soil about two weeks before seeding and at the time the seedbed is prepared. Bands or side-dressings of the other half of the fertilizer may be made later and soon after the plants have established rows. The band is placed about 2 inches from the row and $1\frac{1}{2}$ inches in depth.

Time of Seeding.—Snap beans are not planted until the ground is warm and after the spring frost-free date. Sometimes chances are taken with the

intention of replanting if required. Successive seedings are usually made at intervals of about every 10 days to 2 weeks. To keep a continuous supply of snap beans, it may be advisable to plant several varieties having different periods of maturity. Sowing after summer dry periods succeed in some districts and the crops are harvested in the late fall season.

The broad beans are most frost-hardy but they require a longer growing season. Dwarf snap beans have a shorter growing period than soybeans, however the soybeans may be sown a little earlier as they are resistant to frost.

Spacing, Rate and Seeding Depth.—Bush snap bean rows spaced from 1½ to 3 feet is common where the seed is sown singly in the row. The seed is then spaced 2 to 3 inches apart in the row. In some cases varieties may be spaced 3 to 4 inches apart but reduced yields per acre usually occur. The general rule for depth of planting is 1 inch for heavy soils and 1½ inches for sandy soils. The later in the season the seeding is made and the lighter or more sandy the soil, the deeper the seed may be covered. Depths in some sandy soils of as much as 2 inches have proven satisfactory.

Tillage.—Cultivation with a drag harrow just before the beans begin to push through the soil is suggested. This practice may destroy the small weeds, level the surface soil and fit the soil properly for cultivation after the plants are up. If the ground is weedy, harrowing again before time to cultivate may be helpful.

The two-row cultivators used in plowing corn generally prove satisfactory in bean culture. All cultivations after the beans are up and growing good should be shallow. Furthermore, on account of the danger of spreading diseases, beans should not be cultivated when the plants are damp or wet. Cultivations are made no more frequently than required to keep down weeds and grass and the practice should be discontinued when the plants begin to bloom, as the flowers are easily knocked off the plants. Stirring the soil late may tend to increase the likelihood of damage by early fall frosts. Some hoeing may be needed to remove weeds near the plants.

Varieties of Beans.—There are many varieties available. Some of the dwarf types of bush beans that may mature in about 40 to 50 days are Giant Stringless Green Pod, Bountiful, Plentiful, Tendergreen, Full Measure, Stringless Refugee, Unrivalled Wax, Sure Crop Wax, Round Pod Kidney Wax, Tender Pod, Stringless Green Pod, Bush Kentucky Wonder, and others.

Pole Types.—Kentucky Wonder, Blue Lake, Scotia, Kentucky Wonder Wax, Golden Cluster Wax, Horticultural, and others.

Dry Shelled.—Michelite, White Navy.

Edible Soybeans.—Bansei, Aoda.

Lima Bean Varieties.—Henderson Bush, Butter, Baby Potato, Fordhook, King of the Garden, and others.

Insects and Diseases.—Beans in storage may be freed of weevils by fumigation with carbon bisulfide. The dry beans are sacked and placed in a tight container. Then carbon bisulfide at the rate of 1 ounce to 1 bushel of beans, or 3 pounds to 100 cubic feet of room space, is placed in shallow pans on top of the seed piles. The container or storage is then tightly

sealed or closed for 24 to 36 hours. *Caution!* Carbon bisulfide is very inflammable and should be kept away from fires.

The work of the weevil may be stopped by mixing hydrated lime with the bean seeds at the rate of 1 pound of lime to 4 pounds of seed. This method is adapted to small quantities of stored beans. Weevil damage can be stopped in seed beans that are to be used for food by heating the beans to 130° F. and keeping them at that temperature for 4 hours. The treatment makes the seed unsuited for planting.

Bean beetles may be controlled by using Methoxychlor-50% wettable, 2 teaspoons per gallon of water or 2 pounds to 100 gallons of water. Make the first application when the true leaves first appear. Or Cryolite Dust may be used as soon as the leaves appear. Follow directions on the container. The diseases of beans may usually be controlled or held in check through the practice of good crop rotations, careful cultivations, use of clean and disease-free seed, and growing of resistant varieties in some cases.

BULB CROPS

The bulb crops considered consist of the onion, garlic, chive, and leak. They are closely related botanically and their cultural requirements are similar. The best growth and development is made under rather cool and moist conditions and they are all hardy.

THE ONION
(*Allium Cepa*)

During early growth particularly the crop requires cool moist weather for its best growth. Considerable heat may be tolerated after the plants become well rooted. As maturity is reached, moderately warm, dry conditions give the best results.

The onion is one of the most important vegetable crops. It is widely grown in nearly all of the countries of the world and it ranks high as a commercial crop in the United States. The onion has an extensive adaptation to different soil types and climatic conditions while its general use throughout the year for culinary purposes give it an important standing with the most useful vegetables. It is rarely omitted from the home garden and the commercial acreages are widely distributed over the United States. Intensive methods in growing and handling may be employed and few vegetable crops offer greater possibilities for success.

Planting.—The onion may be propagated by seed, drop sets, and the use of "transplants" or "green set." The seed may be drilled in the soil on well prepared seedbeds as early in the spring as soil conditions permit. In the southern sections, late fall and early winter seedings are common. When the seed is drilled or broadcast without knowledge of a germination test, plant thinning may become a considerable problem.

Rows may be spaced about 12 to 24 inches apart depending upon the requirements of the type of implement to be used in cultivating. The seed should be covered lightly, perhaps not to exceed ¼ inch in depth or less.

Plants are allowed to stand about 2 to 3 inches apart in the row. Where boiling and pickling onions are desired, 10 to 15 pounds of seed per acre may be used to give close spacing and prevent large sized bulbs.

Dry sets produce bulbs that mature earlier than those grown from seed and they are generally of good size. Rapid growth makes it possible to produce a desirable green onion in a short period. Consequently, dry sets are usually preferred in the South and they are meeting with more favor in the North. White varieties usually are preferred. About one quart of

FIG. 50.—Onion seedlings as received in Washington, D. C., from the Thomasville Plant Co., Thomasville, Ga. (Photo by Bureau of Plant Industry, Soils, and Agricultural Engineering, U.S.D.A.)

sets are needed to plant a row 70 to 100 feet long and 10 to 20 bushels for an acre depending upon the size of the sets used.

Green Bunch Onions. Home gardeners usually grow green or bunch onions and market gardeners make extensive use of them. The bunch onions are grown chiefly in the South and they are distributed over the central and northern states. The plants are generally tied in bunches or packs about 2½ to 3 inches in diameter.

Cultivation.—The roots of the onion plant are comparatively compact and the rows of plants are close together. While weed control is important yet care should be taken in cultivating to prevent injury to the onion roots and bulbs. Frequent light or shallow tillage when the weeds are small usually proves satisfactory. Deep cultivation and close enough to cause considerable root pruning may reduce yields markedly.

Fertilization.—Land on which heavy applications of manure have been made for a number of years before used for the planting should prove very fitting for onion culture. In fact, where well-rotted manure is available it may be applied to the soil at the time of soil preparation at the rate of 12 to 15 tons per acre. Complete commercial fertilizers are often used amounting to as much as 1,000 to 1,500 pounds per acre. A fertilizer high in potash may be needed especially on muck lands.

Irrigation.—Few if any crops are likely to respond better to irrigation by producing increased yields and a product of higher color and quality than the onion. Often with years of normal rainfall, there are periods when the onion crop would be greatly benefitted by supplementary irrigation. Wherever possible, the moisture supply should be kept fairly constant as fluctuations may tend to cause the development of split and double bulbs.

Varieties.—On most markets the yellow types are preferred to the red or white. There are rather wide variations between onion varieties as to shape, size, color, keeping quality, firmness, and length of the growing season. Two general classes may be found on the markets. These are "domestic" and "foreign." In the domestic group we find firm bulbs with rather strong-flavored contents. However, they usually mature earlier and keep better in storage than the foreign types which are larger and possess coarser flesh of a milder flavor than the American-grown kinds.

Australian Brown is grown extensively in California because it can be held on the markets for considerable periods without injury. California Early Red is grown mainly for its nonbolting characteristic. In Texas the Yellow Bermuda is a leading variety. It is also adapted to the soils and climatic conditions of other southern states. Crystal Wax is another variety suited to the same regions. Early Yellow Globe is the chief variety for seed in the Connecticut River Valley, sections in New York and Massachusetts. Still other varieties that are used in various parts of the United States are Red Creole, Early Grano, Italian Red, Mountain Danvers, Ohio Yellow Globe, Red Wethersfield, Southport Red Globe, White Globe and Yellow Globe. Sweet, Spanish, Tutah strain, White Sweet Spanish, White Portugal, Yellow Globe Danvers, and others are available to producers. For the sorts best suited to the needs of particular districts, north, south, east or west, perhaps no better sources of information can be found than the State Agricultural Experiment Stations.

Harvesting and Storing.—For storing, onions should be harvested when the bulbs are mature. A fairly safe rule is to harvest when about 60 per cent of the tops have ripened at the neck and fallen over. In large acreages, modern harvesting machinery is used in lifting the bulbs from the soil. The onions are left in windrows in order to dry the tops. Topping machines, shears and knives are used in cutting the tops about ½ inch

above the bulb. Curing is continued and completed in crates and open mesh bags. The time required may range from a few days to a couple of weeks. The length of the curing period will depend a great deal upon the weather. It is well known, however, that onions will not keep unless properly cured.

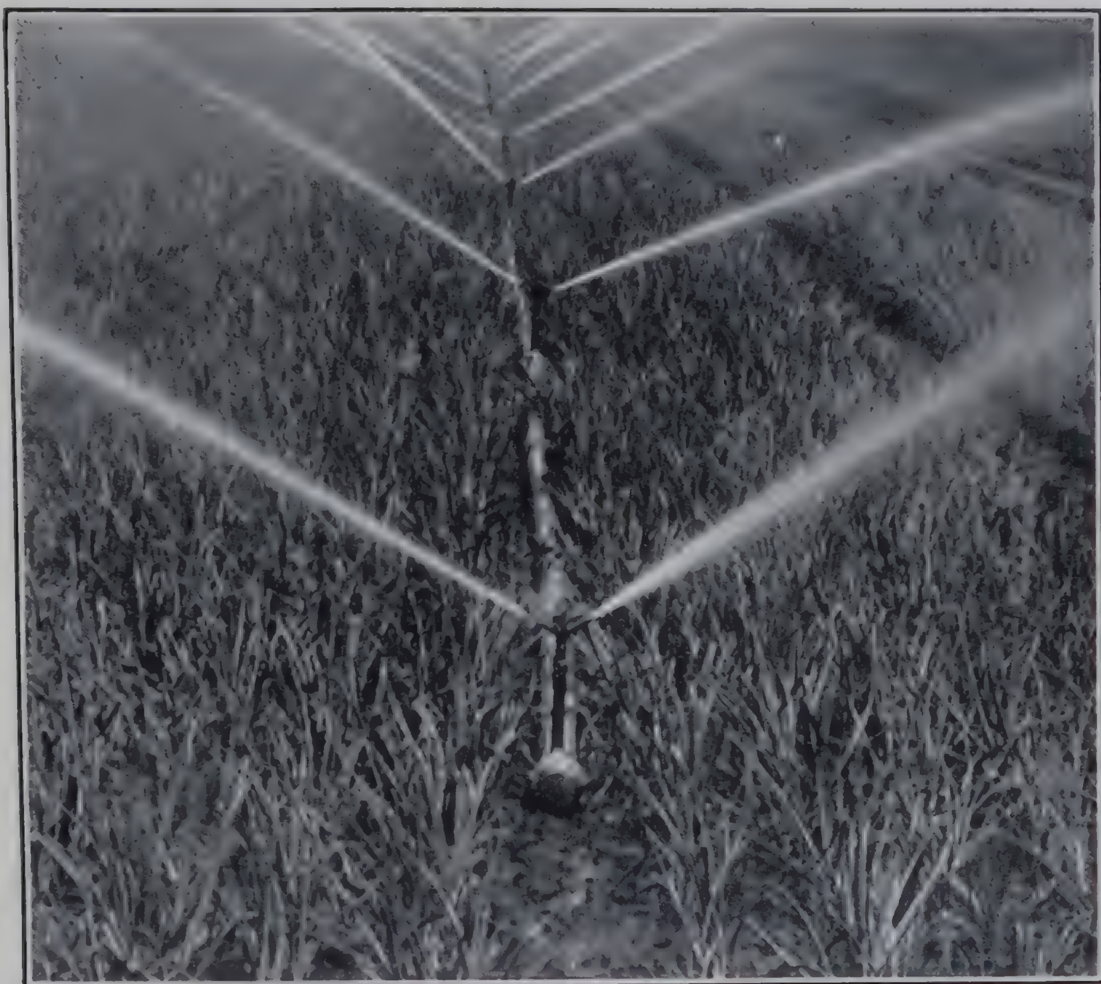

FIG. 51.—Good portable sprinkler irrigation for vegetable row crops. The producer may turn on rain made to order. Even in the humid sections, there is rarely a growing season when vegetable row crops would not be benefitted materially by timely irrigations. The application of water when needed takes the risk out of vegetable growing and enables the producer to place on the markets or in his home a product of higher quality. (Courtesy of Champion Corporation, Hammond, Ind.)

ONION
(*Bermuda*)

The Bermuda type of onion is grown to a considerable extent in the south central and southwestern states. The shape of this onion is much flatter and the flavor milder than any of the common onion types. Some varieties of the Bermuda onion well known are the Crystal White Wax, the Yellow Bermuda (often called the White Bermuda) and the Red Bermuda. The Yellow Bermuda is the principal commercial crop in the southern states, and is also better adapted to most growing conditions. The Crystal White Wax is grown to some extent commercially, but is found mostly in the small home garden.

Nearly all of the Bermuda onion acreage in many districts is being grown from plants shipped in from the Southern States. Texas furnishes most of these plants. The Bermuda plants are grown in the Southern States under conditions much more favorable than the hotbed method in the north. The Crystal White Wax plants are usually quoted somewhat higher than either the yellow or red varieties.

Strong healthy plants are very essential if the crop is to be a success. A plant of good size is one about the size of a lead pencil, from 4 to 6 inches in length, and fairly straight. The plants are usually shipped in bunches of 100 each, and packed in paper cartons, baskets or crates, depending on the number ordered. Only healthy stock plants should be used. Weak plants should be discarded, as they are not profitable. The Bermuda onion will withstand light freezes and frosts. For many sections the plants should be set in the field about March 20 to April 1 while for Southern areas it may be possible to plant from 2 to 6 weeks earlier. Early setting is generally advised.

When setting in the field, plants are placed from 4 to 6 inches apart in the row, and the width of the rows will be determined by the type of cultivation to be used and the fertility of the soil. The rows may be spaced 18 inches or more apart where horse or power cultivation is to be used.

The setting of the plants in the field is usually done by hand. Rows may be opened with a small one-shovel garden plow and plants set in the furrow or the plants may be set out by means of a small pointed stick or "dribble." For commercial plantings many growers use home-made "markers" which mark out a number of rows at a time. The plants should be placed upright in the furrows and from $\frac{3}{4}$ to $1\frac{1}{2}$ inches in depth, depending on the length. The harvesting and storage requirements of the Bermuda onion are the same as for the common onions.

Diseases and Insects.—Smut is a serious onion disease living in the soil where smutted onions have grown. Do not plant onions on smut-infested land if possible to avoid it. Onion Mildew sometimes attacks the plants, causing a wilting and resulting in serious injury. It may be local in spots to start with but rapidly spreads under favorable conditions. Clean cultivation and rotation of crops help to prevent the disease. Spraying with Bordeaux 4-5-50, adding some sticker or spreader to prevent the sprays running off, will aid in the control of the mildew. Spray as soon as the disease first appears and repeat as often as necessary.

Onion Thrips.—Use DDT sprays as suggested for the sweet corn borer.

Maggots.—Use 5 per cent Chlordane dust or wettable Chlordane and emulsifiable concentrate at a dilution of 1 lb. of the actual insecticide in 100 gallons of water.

GARLIC

(*Allium sativum*)

Garlic is much stronger in odor and flavor than the onion. The main commercial areas in the United States are in California, Texas, Louisiana, and Arkansas. In mild growing regions, garlic is a perennial but it is

grown in the North as an annual. The vegetable is widely used for flavoring and seasoning soups, pickles, sausages and other food products. It is held in high regard especially by the people of southern Europe and in the Mediterranean regions.

Most of the commercial crop is grown in central California but garlic may be found in a considerable number of home gardens throughout the country. Fall or early winter planting is generally advised and in the mild climates the crop is harvested in June and July. A soil suitable for growing onions will usually prove satisfactory for garlic. The crop may not bulb properly due to excessive heat and unsuitable length of day. The small cloves or segments located around the main or large bulb are planted. Rows are spaced 18 to 24 inches apart and the cloves are planted about 3 to 6 inches apart and covered with soil to a depth of about 1 inch. Shallow cultivation is best.

Harvesting is done when the tops turn brown or yellowish and the bulbs are usually mature. Drying in the garden or field or under shelter for several days is required before storing. With drying completed, the outer loose parts of the sheath around the bulb are removed and the roots are cut off close to the bulbs. They may be stored like dry onions or tied in bunches.

CHIVE OR CIVE

(*Allium schoenoprasum*)

The dense tufts of slender leaves produced by chives are hollow and are valued highly as a seasoning due to the mild onion-like flavor. Their use may continue throughout the summer and fall. As a garden border or edging, chives may be appreciated on account of the terminal clusters of violet red colored flowers that appear.

The plant is a hardy perennial and the roots may remain in the soil for several years. Propagation is accomplished by dividing and planting the roots early in the spring. Chives are likely to prove successful on any fairly fertile garden soil. Seed may be sown in rows about 12 inches apart and the plants thinned to about 6 inches after becoming well established. To keep the vigor and usefulness of the planting, the roots are usually divided every 3 to 4 years.

LEEK

(*Allium Porrum*)

The leek is a biennial but is grown as an annual, mainly for its long, blanched stems. The plant resembles a green onion as it forms a rather thick fleshy lower stem without a bulb. In contrast to the onion, the green leaves are flat instead of round. When the lower part of the sheaf of leaves or stem is well blanched, it is milder in flavor and more tender than the onion.

Leeks are generally eaten raw but they may be cooked or used for flavoring. In foreign countries such as England, France, Scotland and southern Europe it is much more popular than in the United States. In fact, for the commercial trade it is grown chiefly for the foreign population.

Plantings are handled in the beginning like onions. Seed is sown but generally in a trench or the plants are managed in such a manner as to permit the hilling up of soil on the blanched stems as growth takes place. As an early market crop and for home uses, seed is sown in a greenhouse or hotbed in late winter. As soon as the plants are about 2 inches high they are thinned and a little later transplanted outside in early spring.

Fig. 52.—Leeks. This vegetable is used for almost any purpose that its relative, the onion, is used. (Photo by Bureau of Plant Industry, Soils, and Agricultural Engineering, U.S.D.A.)

When they are set in the garden or field the tops are often cut back about one-half. A trench or furrow 4 to 5 inches deep is preferred for planting. This facilitates blanching as the soil is filled in or drawn up against the stems from time to time as the cultivation work is done.

The rows are placed 12 to 18 inches apart and the plants are thinned or spaced 4 to 6 inches apart in the row. An entire growing season is needed for leeks to complete their growth. They are ready for use as soon as suitable growth has occurred. The stalks are usable when they are 8 to 12

inches long and about $1\frac{1}{2}$ inches in diameter. They may be marketed or prepared for home uses by bunching like green onions. Leeks may be stored well by digging with the roots attached and replanting in moist soil in a cool storage. At a temperature of near 32° F. it may be kept from 1 to 3 months. The soil in which the roots are planted should be sprinkled often enough to keep it moist.

VARIETIES.—Some of the varieties in use are Carentan, London Flag, Musselburg (Scotch Leek), Large American Flag, and Large Rouen.

Chapter 19

Salad, Green and Cole Crops

SALAD CROPS

Lettuce, Celery and Parsley

LETTUCE

(*Lactuca sativa*)

Lettuce is often referred to as "king of the salad plants." This is true no doubt because lettuce enjoys the distinction of being the most sought and extensively grown leafy vegetable. The crop thrives best upon a rich, mellow, sandy loam and it reaches the best development where the temperature of the soil and air is fairly cool and uniform during the growing period.

The heading types require adequate sunlight, a good water supply and fairly cool nights for the formation of solid and compact heads. Few if any varieties of either the leaf or heading types thrive in hot weather. However, in the northern states summer culture succeeds occasionally. Both the spring and fall may be well suited to lettuce and if the cold is not too severe satisfactory crops may be grown during the winter season. The use of cold frames and other protective structures may enable producers to grow lettuce during the winter in the southern sections.

For early crops a sandy loam is desirable, while a silt loam may be preferred for the fall crop. In general, muck soils are ideal for lettuce. Thorough preparation of the seedbed is essential. A loose friable soil with an abundant supply of organic matter tends to make rapid growth and this is needed in a quick maturing crop like lettuce. Animal and green manures may be used successfully. A commerical fertilizer applied at the rate of 100 pounds of nitrogen, 200 pounds of phosphorous and 100 to 200 pounds of potash to the acre should increase yields materially in many instances.

For home use, seed can be sown in the garden and the leaves harvested as soon as large enough. Seeding in rows and thinning the plants to 8 to 12 inches apart, generally gives the best results. However, the rows may be from 12 to 24 inches apart, depending upon the need and the implements used in cultivating.

Much of the commercial crop is seeded in place. When medium to good size is reached the seedlings are thinned by cutting out with a hoe or with a machine adapted to the purpose. It is obvious that early lettuce is more likely to produce satisfactory heads before hot weather begins. Therefore, seed may be started under glass about 6 to 8 weeks before setting. When

the plants are hardened off properly, they may endure without injury temperatures below freezing.

VARIETIES.—Loose Leaf or heading varieties have a rather spreading habit of growth with finely cut and ruffled leaves. Common and well known sorts are Grand Rapids, and Blackseeded Simpson. The latter may withstand the most late spring or summer heat. The Romaine or

FIG. 53. - Great Lakes variety of lettuce mulched with pine needles. (Photo by Bureau of Plant Industry, Soils, and Agricultural Engineering, U.S.D.A.)

Cos types grow upright and produce long heads. Paris White is considered one of the best. Commercial head lettuce varieties used widely in the producing areas are New York No. 12, Imperial including several different types, Iceberg, Great Lakes, and others. It is always advisable to consult local producers, dealers and county agents for varieties best suited and adapted to local conditions.

INSECTS AND DISEASES.—The nature of the crop and the kind of culture given makes controls usually dependent to a considerable extent on crop relations and the use of resistant varieties.

CELERY

(*Apium graveolens* var. *dulce*)

Celery has an extensive use particularly in the United States and Canada. With lettuce it is the chief vegetable crop eaten without cooking. It is a biennial plant and the edible portion is the leafstalk or petiole. The plant is used in such foods as soups and broth, salads and as a relish with cheese. It has a place in purée as a spiced product and it is made into sauce. Fried celery is also highly prized.

The crop requires a well distributed and ample supply of moisture. It is not grown from seed sown directly in the field or garden. A long growing period is needed for growth and maturity. The seed is started under glass and the seedlings are transplanted. The crop is not as easy to grow as most garden crops as considerable specialization is required for good results.

Muck soils are ideal for growth because of good water holding capacity. Sandy and silty loams may prove satisfactory. Thorough preparation of the planting bed is essential. A soil reaction of about pH 6 is desired. On mineral soils manure is particularly valuable. Nearly all soils may require for good growth, one or more side dressings of 30 to 50 pounds of nitrogen per acre. From 10 to 20 tons of manure per acre may be needed on good loam soils. A complete fertilizer like 10-20-10 at the rate of 600 to 800 pounds per acre may prove profitable.

Cultivation should be begun as soon as the plants are established and continued until blanching time. Few if any vegetables respond better to stirring the soil and maintaining a good soil mulch. Shallow cultivation is best as celery is not deep rooted.

VARIETIES.—Golden Self-blanching is one of the most important sorts. Easy Blanching is somewhat later than Golden Self-blanching. Giant Pascal is a dark-green high quality variety. Varieties such as Salt Lake and Utah are similar to Pascal. For home uses the Emperor has a wide use. It ranks high for quality and develops comparatively few brittle petioles.

BLANCHING.—To improve the tenderness, flavor and color of the stems or petioles blanching is practiced. On each side of the row, paper or boards may be placed against the plants to a height of about 10 to 12 inches. The paper or boards may be held in place by wire staples or hooks. The lower edges are covered with soil. In about 10 to 14 days blanching may be completed. The paper or boards may be moved to another lot of plants on the completion of each set of treated plants. Celery planted in 18 to 24 inch rows may blanch itself where the tops produce a strong growth and provide sufficient shade.

HARVESTING AND STORING.—Most of the harvesting occurs in late fall or early winter after the crop is mature and blanched properly. For home and local uses a sharp spade may be used to cut the plants about 1 to 2 inches below the crown. In commercial plantings special machines are employed for the harvesting work.

With rows 3 to 4 feet apart a yield of 300 crates to the acre is about average, while under close planting, 18 to 24 inches, and good culture

yields as high as 600 crates per acre are possible. Cold storage is most satisfactory but cellars, caves, pits, and trenchs are used successfully.

INSECTS AND DISEASES.—Serious problems with insects and diseases may not be encountered under good culture, irrigation and the use of good crop rotation systems.

GREEN CROPS

COMMON SPINACH, NEW ZEALAND SPINACH, ORACH, MUSTARD, KALE AND CHARD

PARSLEY
(*Petroselinum hortense*)

This crop is widely grown as a garden herb. The leaves are used to garnish or decorate foods like meats and sandwiches. The sprigs give a distinctive flavor to stews, soups and sauces and they may increase the attractiveness of other foods when used properly. It is hardy and may be grown in the open from seed or started like celery and transplanted. Soaking the seed may shorten the time of seed germination.

As parsley is a cool weather crop, it may be grown in the open all winter in the South. However, it is generally grown from planting seed each spring. A few feet of row may produce an abundant supply for a family. For late fall and winter uses, a few plants set in a cold frame may be ample for winter and spring.

A fertile soil well supplied with organic matter and moisture is needed for good growth. Side dressings of nitrogen after the plants are started usually promote rapid growth and high quality.

VARIETIES.—For garnishing dishes Paramount and Champion are important varieties. Evergreen, a comparatively new variety is resistant to drought. For use in stews, soups, and the like, Plain or Single types are produced.

Parsley is not subject to serious attacks of insects and diseases. Leaf-eating insects may be controlled through the proper use of the insecticides generally employed for such pests. Good culture and the rotation of crops may prevent disease attacks.

COMMON SPINACH
(*Spinacia oleracea*)

Spinach is one of the most important vegetable crops grown for "greens." On account of its high mineral and vitamin content, spinach is given a good rating in the diet. A satisfactory yield ranges from about 30 to 35 pounds from 100 feet of row. The crop is produced extensively for canning and in the milder sections it is grown widely as a winter crop. From sowings made in the late fall it is grown chiefly as a spring crop. Harvests are placed on

the markets as a fresh vegetable or sold to canneries. Some of the most important producing states are California, Maryland, Virginia, and Texas. Yields of 500 bushels or more an acre are possible.

It is a cool weather, quick maturing crop and may occupy the land for only a short time. In regions with mild winters it is one of the best fall and winter vegetables to grow. Development proceeds at temperatures a little above freezing but the optimum warmth is somewhat above freezing.

The largest yields are usually produced from the heavier soils consisting of loams and silts. A rich soil well supplied with moisture gives the best results. Muck soils for canning spinach often give excellent results. To obtain rapid, luxuriant plants and a good green color, the liberal use of manures and chemical fertilizers may be needed. Manure used at the rate of 7 to 10 tons per acre or a half ton of a commercial fertilizer like 10-10-10, one or both, may be needed. Home gardeners may secure satisfactory results by using a good application of manure or a complete fertilizer or nitrogen alone at the rate of about 1½ to 2 pounds per 100 feet of row. Rarely if ever can the producer determine the exact amounts of manures or fertilizers that will prove profitable without making local trials or tests for his particular soils and climatic conditions. Also, this statement applies equally as well to other vegetables.

The chief varieties consist of the smooth-seeded type. Some of these are Virginia Savory, Norfolk, and Old Dominion. Slower growing varieties that are less likely to bolt to seed are Juliana, Long Standing Bloomsdale, Victoria and Long Season.

NEW ZEALAND SPINACH

(*Tetragonia expansa*)

This plant is not a spinach. However, there is some resemblance between the two kinds. New Zealand spinach is a native of New Zealand, Japan, Australia and South America. It is not as palatable as common spinach and only the tips of its branches are harvested. It is considered an excellent potherb, easy to grow and a crop may be produced throughout the summer.

New Zealand spinach may serve as a substitute for common spinach when the latter is unable to withstand the heat and drought of summer. It does not bolt to seed during long hot days and is useable until early autumn.

Due to its rank growth and large size the rows should be 2 to 4 feet apart. The seed is sown about 1 inch apart and later the plants should be thinned to about 1 foot apart in the row.

ORACH

(*Atriplex hortensis.*)

This greens plant is suggested for planting particularly in the Great Plains region where spinach culture is somewhat difficult. Some of the advantages of this so-called French or Mountain Spinach are that it can be grown under considerable neglect, a greens crop may be made available

where it is difficult to grow the common spinach because of bolting, the plants are tolerant of alkaline and saline soils, and its upright growth prevents the leaves from injury to some extent by windblown sand.

The most popular variety in the Great Plains and mountain areas is Triumph. While the best product is from plants about 4 to 6 inches high, the growth may reach a height of 6 to 9 feet. Other varieties such as Gelbe and Green Double-Headed are listed and they have their advantages. Good spinach culture applies equally well to Orach.

MUSTARD

(*Brassica juncea* and *B. alba*)

A fertile moist soil is needed for the best results. Harvests from this crop are usually limited to spring, fall and winter, however, it is possible under fairly cool conditions and irrigation facilities to gather mustard greens all year if successive plantings are made.

Black or brown mustard is grown chiefly for seed production in the manufacture of table mustard. White Mustard produces a vigorous plant but it may bolt to seed quickly. The dark green leaves are used in salads when young and the brown colored seeds are valuable for making table mustard.

Some of the varieties being used are Fordhook Fancy, Giant Southern Curled, Chinese Broad Leaved, and Elephant's Ear. The seed is sown in rows 2 or more feet apart and the plants are thinned to about 6 inches apart. Seed is often sown at two-week intervals for greens crops.

KALE

(*Brassica oleracea* var. *acephala*)

This crop is a member of the cabbage family. The large leaves produced are used for soups and as greens. Kale is perhaps the nearest relative of the wild sea cabbage (*Brassica oleracea*) which may still be found growing on the sea cliffs of England and elsewhere in Europe. Kale is even more resistant to cold than cabbage. It also thrives fairly well on poor soils but gives the best results on fertile ground. Plants are set in rows 1 to 2 feet apart. The dwarf varieties are preferred. The crop may be harvested by taking the larger young leaves or by cutting the entire plant. Yields range from about 150 lbs. for a 100-foot row to 250 barrels for an acre.

CHARD

(*Beta vulgaris*)

This vegetable is known as Swiss Chard, leaf beet and silver beet. The leaf stalks are fleshy and large and the leaves are thick and broad. As a potherb it ranks as one of the best. The stalks and leaves are frequently chopped together, and consumed as asparagus. Chard may also be substituted for spinach and it is used from midsummer to fall.

The crop is particularly well suited to the home garden in locations where it may be difficult to grow garden crops. Harvesting of the outer leaves may be repeated from time to time without apparent injury to the plants.

The rows should be about 18 inches apart and 12 to 15 seeds planted to each foot of drill. When the plants are about 6 inches high they are thinned to 3 or 4 inches and on fertile soils thinning to 8 or 10 inches apart may prove helpful.

Fig. 54.—Swiss Chard, especially suitable for hot-weather culture. (Photo by Bureau of Plant Industry, Soils, and Agricultural Engineering, U.S.D.A.)

Lucullus is generally considered the most desirable variety. Other sorts are Fordhook Giant, Rainbow and Rhubarb Chard. The plants will withstand considerable freezing. In some sections of the North the plants under heavy mulching will winter without injury. They may be easily protected with cold frames and forced early in the spring. In forcing early growth nitrogen fertilizers are usually valuable. Acre yields may amount to as much as 5 tons or more.

COLE CROPS

Cabbage, Cauliflower, Broccoli, Cauliflower Broccoli, Brussels Sprouts, Chinese Cabbage, Kohlrabi and Collards.

All of the vegetables classed in the Cole Crops group are closely related and are members of the genus *Brassica*. The Rutabaga is essentially a cole but it is discussed under root crops. Cole crops produce thick, heavy and bluish colored leaves. They rank among the hardiest of vegetables and grow particularly well in cool climates or the cooler parts of the growing seasons.

CABBAGE

(*Brassica oleracea* var. *capitata*)

Cabbage may be grown successfully over a wide range of climates and different soil types. For its best growth and development a cool moist climate is required. Well hardened young plants may tolerate temperatures of 20-25° F. It is a typical hardy cool season crop. In the North, producers plan to have cabbage mature in early summer or fall while in the South the objective is to have maturity and harvests in the late fall, winter or early spring. Where cabbage may be overwintered, early spring harvests are possible.

The crop is of considerable economic value as it may be found on the market as a wholesome and reasonably priced vegetable throughout the year. Furthermore, it is generally one of the easiest crops to grow in the home garden and both late spring and fall harvests may be had in most sections. Cabbage is thoroughly enjoyed by nearly everyone as sauerkraut, boiled cabbage, salads, and as pickled products. A satisfactory yield per acre is about 8 to 10 tons; heads from early production usually weigh 2 to 4 pounds and late cabbage heads 4 to 6 pounds per head.

In general light sandy soils are preferred for early cabbage and overwintering crops. Heavier soil types including muck soils usually produce higher yields from late varieties. Cabbage is considered an extensive and heavy feeder on soil fertility. Fairly good fertility, soil texture and moisture are required for high quality and profitable production. Manure, compost and chemical fertilizers may be used liberally in crop production. Both phosphorus and potassium as well as nitrogen may be required. A 1:2:2 ratio of the main chemical elements may give satisfactory results.

Plenty of space should be allowed between the rows and in the rows for good growth and development. Clean cultivation is required to keep down weeds and grass as much moisture is needed. As the plants become larger and about half grown, care in cultivating should be taken to prevent destroying cabbage roots. It may be easy by cutting roots to do more harm than good. In dry periods particularly the crop will respond profitably to irrigation.

Small types may be spaced in rows 12 to 15 inches apart but large kinds need 18 inches or more. Rows range from 24 to 36 inches apart. Close spacing is used to reduce size of head to meet market requirements. Other members of cabbage family have like spacings.

Varieties.—Some of the leading varieties are Jersey Wakefield and Charleston Wakefield. Both produce pointed heads of high quality weighing 1 to 2 pounds. Golden Acre is another early variety with slightly flattened heads weighing about 3 pounds. Still other good and standard

varieties are Copenhagen Market strains, Glory of Enkhuisen, All Head Early, Succession and All Seasons. Other late flat types are Late Flat Dutch and Surehead. For late storage cabbage the Daniel Ball Head or Hollander are types valued highly. The red varieties are generally used for pickling. Some of these are Round Red Dutch and Mammoth Rock Red.

CAULIFLOWER

(*Brassica oleracea* var. *botrytis*)

Although a close relative of cabbage, the cauliflower is considerably more difficult to grow. Naturally a cool moist climate is needed. However, the crop will not withstand as low temperatures as cabbage and it should be planted a little later than cabbage. The crop is much more difficult to grow successfully in dry, hot weather. Steady growth free from stoppages is highly essential. The results desired may often be attained through timely irrigations.

FIG. 55.—A good head of cauliflower. (Photo by Bureau of Plant Industry, Soils, and Agricultural Engineering, U.S.D.A.)

Good cabbage soil should in general be satisfactory. Cauliflower soil should be fertile, in proper physical condition and contain sufficient humus to make it retentive of soil moisture. Leguminous crops such as sweet clover, alfalfa, soybeans, cowpeas and others when plowed under and allowed to decompose properly may become well suited for growing cauli-

flower. Top dressings of nitrogen fertilizers applied at intervals during the early and midseason growing periods should prove helpful in promoting continuous good growth. The crop may also respond to applications of phosphorus and potassium made before planting.

Cultivation should begin soon after the plants are set and be continued often enough to keep down weeds. Care is required to prevent cutting and destroying roots by deep and close cultivation. It is usually advisable to discontinue the practice when heading begins.

FIG. 56.—Sprouting broccoli, a worthwhile garden vegetable. (Photo by Bureau of Plant Industry, Soils, and Agricultural Engineering, U.S.D.A.)

The quality of cauliflower is dependent chiefly upon the whiteness of the heads. Injuries due to frost, rain, sun or insects causing the heads to turn brown and yellowish may lower the quality materially for home or market uses. The heads of early varieties are frequently blanched by drawing the outer leaves over the head and tying them with strong string or raffia near the flower head or at the tip. The favorable time to tie is when the leaves covering the head begin to break away and expose the young head. Another method of blanching consists of breaking the midrib of the leaves,

then bending them over and tucking the tips down around the head. When the work is done carefully good protection for the head may be provided.

Some of the varieties now being used in home and commercial plantings are strains of Super Snowball rated as one of the best for the early crop. Early Erfurt is much like Snowball but the strains may differ in earliness. Late types are Autumn Giant, Dry Weather and Danish Giant. It is important that the producer use great care in the selection of strains of cauliflower for his plantings. The strains may differ widely in the production of marketable heads and in the time of maturity.

SPROUTING BROCCOLI

(*Brassica oleracea* var. *italica*)

Two distinct types of this vegetable are recognized. It is important that the kinds be clearly differentiated. The three classes of broccoli are green, white, and purple. Green types are most popular on the markets and for the home gardens. Sprouting broccoli is especially distinctive. It is in demand at high class hotels and restaurants and is appreciated when produced on small plots for home consumption. When compared to cauliflower, this crop does not require blanching and it is a little more heat resistant. It may also be harvested over a longer period than cauliflower.

The soils and fertilizer treatments suggested for cauliflower should prove satisfactory. This would include particularly a soil well supplied with organic matter, the use of readily available nitrogen fertilizers like nitrate of soda, sulphate of ammonia and ammonia nitrate. One or more side dressings of nitrates may be needed where growth may be slow and uncertain.

VARIETIES.—*Freezers' Sprouting Green* is especially well adapted to commercial freezing. *Propageno* is about a week or 10 days earlier than *calabrese*. About 70 to 75 days are required for the maturity of *Italian Green Sprouting Early*, while *Green Sprouting Medium* is nearly three weeks later in reaching the harvesting period. For early spring cutting and home uses *Green Sprouting late* which has few if any side shoots, is planted in the fall in California, along the South Atlantic Coast and in other locations where similar climatic conditions prevail.

CAULIFLOWER BROCCOLI

(*Brassica oleracea* var. *botrytis*)

Unfavorable weather conditions may have a marked effect upon cauliflower broccoli as the plants are very susceptible to injury from rapid changes in temperature. It requires about six months after planting to reach the harvesting stage. Fairly cool weather with plenty of moisture is required for good growth. The crop is rather difficult to grow and the long period of development may increase production costs. In general, the culture is similar to that of the Sprouting Broccoli. A popular variety is St. Valentine.

BRUSSELS SPROUTS

(*B. oleracea* var. *gemmifera*)

This vegetable has been grown in Belgium for several hundred years and its name comes from the city of Brussels. The small heads or edible sprouts of the plant are about the size of the Black Walnut and they grow from the bottom of the plant upwards. Thick clusters of the buds or sprouts are formed in the axils of the leaves, around, and along the main stem. Like other members of the cabbage family Brussels Sprouts require for the best growth and development a cool climate with an abundance of moisture. Extensive producing centers may be found in California, Long Island, New York and in other sections where more or less marine climates prevail.

Fig. 57—Brussels sprouts. The sprouts are borne in the axils of the leaves. (Photo by Bureau of Plant Industry, Soils, and Agricultural Engineering, U.S.D.A.)

Soils of high fertility and plenty of moisture are best. The plant is a heavy feeder and makes exacting demands upon the soil. Ample quantities of soil organic matter in the form of manure or green manuring crops is needed for profitable production. In fact, all the good culture suggested for late cauliflower applies equally well to Brussels Sprouts. Timely cultivations to keep down vegetation is essential. However, since much of the root system may be within 2 to 3 inches of the soil surface, shallow stirring of the surface soil cover is best.

Harvesting may begin in about one hundred and fifty days after transplanting in the field. The basal sprouts develop first and harvesting starts at the bottom of the plants by breaking off the leaf below the sprout. The sprouts are then broken from the stalk. From the base of the plant

upward successive harvests may be made as the buds reach maturity. Each vigorous plant may produce a quart or more.

VARIETIES.—A few tall varieties about 25 inches in height are Danish Prize, Matchless and Amager Market. Half dwarf sorts are Long Island, Half Dwarf and Dalkeith. Dwarf varieties averaging below 20 inches are Dwarf Perfection and Dwarf Gem.

CHINESE CABBAGE

(*B. pekinensis* and *B. chinensis*)

Producers generally have difficulty in getting Chinese cabbage to head properly by seeding in early spring. This is true because under most conditions undesirable seedstalks are formed. Even where plants are started under glass and transplanted promptly to the field worthless flower stalks are likely to be produced.

Therefore, in the North the general practice is to plant the seeds in the fall and in the South the seedings are made in late fall or early winter. Furthermore, the seeds are sown or planted where the crop is to mature. Seedings begin in July in the northern areas and toward the southern sections the months of August and September may prove satisfactory. The rows are usually made about 24 to 30 inches apart and the plants are thinned to stand about 18 to 24 inches apart.

Some of the varieties being used are Chihli which forms long slender heads. Pe-Tsai forms heads ranging from medium to long and Sakigake may be earlier and its heads are usually shorter. Chinese White includes strains of Wong Bok. Hagaromo forms loose heads and Giant Shuntang is another loose-leaf type. Harvest when heads become hard.

KOHLRABI

(*Brassica caulorapa*)

The Kohlrabi is often known as the Turnip-Rooted cabbage. The crop may be found as easy to grow as cabbage. The edible portion of the plant is the swollen stem, which is grown above ground. It may be peeled and eaten in the raw stage. If cooked before the flesh becomes woody, it may be found to be superior to the turnip in taste or flavor. Consumers acquainted with the vegetable give the early crop a high ranking on account of its delicious flavor and acceptable texture. The small heads may be cooked like cabbage or served as a salad.

Some growers prefer to sow the seed in hotbeds or cold frames and transplant to the field. The early varieties may be forced in cold frames and transplanted under glass for a period before setting in the field. In this way much earlier production may be had. For success in growing, the plants require the same general treatment that is given in good cabbage culture.

Rapid growth is required for high quality and a tender product. The swollen stems should be harvested when they have reached a diameter of about 2 to $2\frac{1}{2}$ inches. Just below the swelling the stems are removed. Several

may be tied in one bunch. An acre yield is estimated at approximately 16,000 bunches. When the leaves are removed Kohlrabi may be stored successfully like turnips or cabbage. White Vienna and Purple Vienna are popular varieties.

COLLARDS

(*Brassica oleracea* var. *acephala*)

Collards will withstand successfully more heat than cabbage. The crop, therefore, may be substituted for cabbage particularly in the southern districts where it may be continued through the winter without material injury. It resembles the tall kales in growth habits and has been described as a non-heading cabbage. The plant produces smooth instead of crimped leaf-blades. True heads are not formed, but a large cluster of leaves are produced. These are often tied together or covered for blanching. The crop is used extensively for greens.

The planting, cultivating and general care of the crop is much the same as for cabbage. A soil well supplied with humus, and fertile is desirable for good production. Seed may be sown in early spring or in midsummer. Following seeding, spacing by thinning is often practiced. Rows are usually made 3 to 4 feet apart and the plants spaced about 1½ to 2 feet. Popular varieties are Louisiana Sweet and Georgia Collard. Harvest the tender top leaves or the entire young plant may be removed.

Chapter 20

White Potato and Sweet Potato Crops

WHITE POTATO
(*Solanum tuberosum*)

THE Irish or white potato is a native of South America and it has been under cultivation by the Indians of Peru, Colombia, Ecuador, Bolivia and Chile since very ancient times. It was introduced in Spain about 1565. Here and elsewhere in Europe the potato was considered with distrust for nearly a century and many refused to eat it because they thought it was poisonous. This notion was largely due to solanin, a poison compound which is found in the green parts of the plant. In the United States, potatoes were introduced from Ireland in 1719 and grown first in New Hampshire. The vegetable and horticultural crop is the most important one known and ranks as one of the chief food crops of all nations. Few if any other cultivated crops have such a wide range of adaptability or capacity for good yields. Consequently the white potato is a staple food in practically every civilized country of the world.

Some Commercial Uses

According to the United States Department of Agriculture Yearbook, 1950–1951, we process about 22 million bushels of the 300 million produced for food each year. Potato chips account for an additional 18 to 20 million bushels, and other products make up from 2 to 4 million bushels. In most years nearly 2 million bushels are used in the manufacture of potato flour. Furthermore, when the need arises as it did during the Second World War 10 or more million bushels yearly may be dehydrated for special uses.

Through less waste, time conserved, and the convenience experienced, dried and canned potatoes, have met in a remarkable and striking manner, the demands of consumers generally. It is now well known and a demonstrated fact that both canned and dried potatoes are a success and acceptable products. Still other appetizing potato products have filled a real need and are appreciated by the buying public. Some of these consist of such specialties as shoestring and hash-brown potatoes, french-fries and potato chips. In fact, potato chips are so popular, they are now the leading potato product.

Starch factories provide an important outlet for potatoes that should be withheld from the markets in order to make effective the slogan: "Sell the best and process the rest."

Potatoes are an excellent food on account of the carbohydrates, proteins and minerals that they contain. Also, they furnish splendid nourishment for molds, bacteria, and other microbial forms of life. In Europe, potato alcohol has long been used in vodka and other liquors. It appears that there is little if any difference in taste between grain and potato alcohol. Other products from potatoes are known as industrial alcohols which are valuable in the manufacture of lacquers, the synthesis of organic chemicals and other materials. From the 1948 crop, 34 per cent of the 133 million bushels purchased by the Government were used in the fermentation of alcohols including ethyl alcohol.

Temperature Conditions

The potato has uniformly been most profitable in the cooler sections of the country. The mean annual temperature is believed to be about 40° to 45° F. and for tuber development and yield the optimum temperature is about 63° F. In the growth of the potato, the so-called critical temperature period, or period of unfavorable influence on yield, is during the time of tuber set and development.

In the South, the crop is grown in the late winter and early spring, while in the North the producer plants at a time when the crop will come to maturity during the cool period of late spring, early summer or fall. Furthermore, soil temperatures are important. It is possible that the chief advantage of both muck and peat soils is due to the relatively low temperatures prevailing just below the soil surface. Soil mulchs may in dry season particularly lower the temperature near the tubers and tend to increase production.

Cultural Requirements

Soils.—The potato may succeed well on a great range of different soil fertilities and soil types, yet it does best on fertile sandy, gravelly or shaly loams. Less desirable soils consist of heavy sticky clay and very light sandy types. Both muck and peat soils have been found to be in general satisfactory for potato production. Finally, it is highly important to obtain as nearly as possible a loose friable soil with an ample supply of organic matter and one which is deep, rich, well drained and contains an adequate moisture supply either from natural or artificial sources.

Soil Fertility.—Potatoes are generally considered as heavy soil feeders, yet few crops leave the ground in better condition for the planting of succeeding crops. To keep up the soil fertility and lessen the injury from disease producing organisms particularly and to some extent relieve the severity of insect attacks, potatoes should be grown in a suitable rotation.

Manures and Fertilizers

Manure at the rate of 20 to 25 tons per acre may supply a sufficient balanced fertility for the production of a crop of 350 to 400 bushels an

acre. Rarely will manure be available in such quantities for commercial production. Growers will usually, therefore, be required to rely chiefly upon cover crops, green manuring crops, crop rotations and the use of both commercial nitrogen and complete fertilizers for improving and maintaining soil fertility. Potatoes may respond to the use of nitrogen, phosphorus or potash alone or in combinations. In fact, chemical fertilizers may be relied upon entirely, separately or as a supplement to the use of manure or crops plowed down in an established rotation.

If possible before planting potatoes the soil organic matter should be built up. In most instances this operation will be most practical through the use of crop rotations, plowing under cover crops and the incorporation of manure in the soil if available. The use of rather large amounts of commercial fertilizers may be justified through increased yields.

Complete fertilizers such as 5-10-10, 8-16-14 and other combinations may be applied profitably at such rates as 1000 to 1500 pounds to the acre depending on the soil analysis, type of soil, past cropping and handling. Somewhat less potash may be required on the heavier soil types but a little more phosphorus may be needed. Muck soils will usually respond well to much heavier applications of these elements and liberal amounts of nitrogen may be important on all lands where cropping has been fairly regular and heavy.

These chemical fertilizers are usually applied at planting time through an attachment on the potato planter. In making heavy applications particularly, care should be taken to prevent contact with the potato seed as damage or injury to seed and sprouts may occur. Optimum yields may be obtained in soil having reaction tests of pH 4.8–5.5 (acid reaction). Generally lime or alkaline materials should not be added unless the reaction is below 4.8. In some instances sulphur is used to reduce a high pH of potato soils to a more favorable reaction.

Varieties

Irish Cobbler is an important and popular early variety. It is uniform in quality, spherical in shape and creamy white in color. The eyes are fairly deep. The foliage is tolerant of warm weather, resistant to the attacks of leaf hopper, dark green and vigorous. Its long rest period discourages sprouting and shriveling and it keeps well in storage.

Bliss Triumph is classed as early to medium. It is a commercial variety for sections in Texas, Louisiana, and Florida as a large portion of the crop is distributed in the northern markets. Good yields are obtained even on heavy soil types. The variety is well suited to the higher altitudes especially of Colorado and Idaho. The conical shaped tubers, red in color with deep eyes located near the stem are attractive on the markets. Tubers may range from small to medium in size and are blocky in shape.

Early Ohio is generally considered to be slightly better in quality and a little earlier than Irish Cobbler or Bliss Triumph. However, under most conditions yields may be considerably less. Growth cracks and knobby tubers may be a hinderance in growing the variety.

Other varieties meeting with considerable favor in the different producing sections are Red and White Warba and Waseca, which are very early; White Rose grown extensively in California; Green Mountain, medium late but high in quality and stores well; Rural New Yorker, a late sort but a leader throughout the country; Russet Rural a late sort having a russeted skin; Peach Blow an old variety but important in some sections and especially in Colorado; and still newer varieties with their advantages and disadvantages are Chippewa and Katahdin. Other new late sorts are Cherokee, White Essex, White; Kennecbec, White and Red Pontiac; Sebago, White and White Rose; Earlaine, Houma and Sequoia are being tested.

Soil Preparation

Thorough and proper soil preparation is essential for the best results. Under some conditions plowing to a depth of 8 to 10 inches may be advisable. In other instances where plowing in the past has not been to this depth, a lesser plowing depth is suggested and the greater depth reached gradually through several plowings in later years. Also, fall plowing may be advised in some sections while in others this may result in considerable soil erosion or soil blowing. Plowing in late fall or early winter and leaving the ground rough may give good results in some districts but in other areas the practice may be unwise for obvious reasons.

In preparing sod ground such as alfalfa, clover and blue grass special treatment is usually suggested. Since sod lands are likely to be infested by white grubs and wire worms that may do serious injury to potato tubers, such soils are usually planted to small grain crops, corn, sorghum or hoed crops for about two years before planting potatoes. The fertility of the soil should be kept up by adequate fertilization while preparing it for potatoes.

The ground for late potatoes in the Central States areas should be plowed in early spring and harrowed or disked at regular intervals to keep down weeds and conserve moisture until potato planting time in June or early July. Good preparation of the seedbed may be equal to two or more crop cultivations. Furthermore, the potatoes are given a splendid start when planted on a thoroughly prepared soil. No amount of later cultivation can make up for poor soil preparation for planting.

Seed and Seed Certification

The potato tubers are known as "seed" although they are underground stems. However, true seed-balls are produced from flowers on the tops of the plants. Some varieties rarely produce seed while other sorts if given an opportunity may develop seed-balls or pods practically every year. In the development of new potato varieties true seed must be used.

True certified seed potatoes carry on the containers an official tag on which may be found the state seal, name and address of the grower and the signature of the state inspector. Such factors as vigorous plants, firmness of tubers, freedom from diseases and the compliance with regulations

governing growing, harvesting and storing practices are met and accepted by certified seed growers.

Seed certification means that the potato seed stock offered for sale has passed the requirement of the State Seed Certification Regulations. To qualify as a producer of certified seed, a grower may have at least two field and one bin inspections. Furthermore, unless the seed meets the requirements imposed including the tolerances allowed, certification is not granted. Naturally certified seed usually commands a higher price than seed which has not been certified, but the best producers are of the opinion that the extra cost of the seed may be slight as compared to the increased yields which may be expected from good seed certification regulations and compliance.

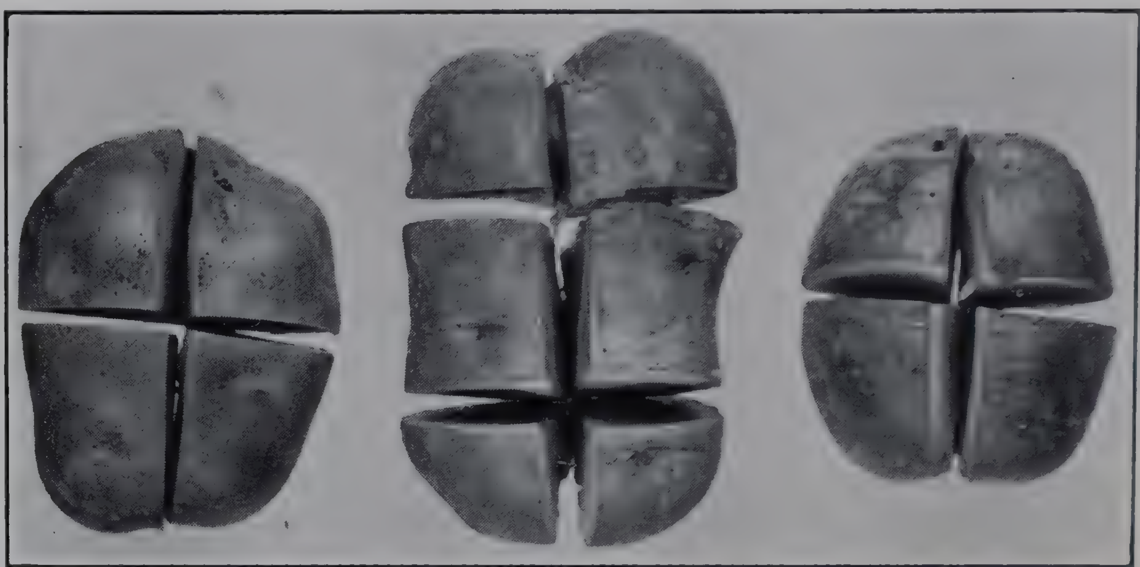

FIG. 58.—A method of cutting potatoes as seed for planting. (Mo. Agr. Exp. Sta.)

Some approved certified seed sources for Irish Cobbler and other established varieties are Minnesota, Wisconsin, Michigan, North Dakota, Colorado, Maine, New York and Prince Edward Island, Canada. Northern certified seed stock is generally used in planting the early and main crops in the South and North. This is true because seed stock of comparable freedom from diseases and ability to produce high yields is rarely possible in the South or Central area.

Seed Treatment Against Surface-Borne Diseases

Since all seed potatoes including certified seed may contain varying amounts of disease organisms adhering on the surface of the tubers, seed treatment is recommended. No method of treating the seed, however, will free the tubers from internal diseases such as virus diseases. However, some of the surface-borne diseases that may be destroyed by seed treatment are black scurf (Rhizoctonia) and scab. Producers of every section or district should secure full and complete information and suggestions from their respective Agricultural Experiment Stations regarding potato seed

treatment as the methods and practices may vary somewhat from station to station.

METHODS OF SEED TREATMENT.—According to the Missouri Agricultural Experiment Station the only equipment needed is a barrel or tank, a drain board, and baskets. To keep two cutters busy, use half of a wooden barrel with a 3 by 10-foot drain board made of 1-inch lumber covered with roofing paper, and a dozen 1-bushel stave baskets. This equipment is adequate for a field of twenty acres or less. Metal containers and wire baskets may be used if they are covered with a good coating of asphaltum paint. The drain board should be placed so that after treatment the excess liquid will drain from the potatoes and back into the barrel.

Organic Mercury Dip

There are several organic mercury compounds sold on the market under various trade names. One of the more commonly used compounds is available under the trade name "Semesan Bel." These organic mercury materials are simple to use and are quite effective. Since no soaking period is required and unpainted metal containers can be used, this method of treatment may prove especially satisfactory for the small growers and the home gardener. In using, follow the intructions on the container label.

Yellow Oxide of Mercury

An effective and simple treatment is made by using 2 pounds of yellow oxide of mercury (technical grade) to 30 gallons of water. This material should be stirred vigorously into the water with a wooden paddle. It will not dissolve but remains in suspension. The baskets of potatoes should be plunged up and down in the suspension two or three times to insure thorough wetting of the tubers. All that is necessary is to be sure that the entire surface is thoroughly wetted. The suspension must be kept stirred to prevent settling. The agitation given by the baskets is usually sufficient. Thirty gallons will treat about 200 bushels of seed.

CAUTION.—All treating solutions are poisonous, and should be carefully disposed of after use.

Cutting the Seed

Only well-shaped, disease-free potatoes should be used for seed purposes. Each seed piece should contain one or more healthy eyes and average from 1½ to 2 ounces in weight. In general, blocky seed pieces are to be preferred to wedge-shaped pieces. The potatoes should be planted soon after they are cut. Where the acreage planted is large, it may be necessary to cut a considerable quantity of seed before planting operations start. Under such conditions the seed pieces should be stored at a temperature between 70° and 80° F. and at a humidity of 85 to 95 per cent. With such treatment the cut seed pieces should cure properly and show resistance to deterioration in case of unfavorable growing conditions.

In storing cut potatoes they should not be piled too deeply as under such treatment heating is likely to take place and the sprouting and growing ability may be reduced. The amount of seed required per acre will vary with the variety, size of potatoes used for seed, and planting distances or spacing. The Irish Cobbler, having fewer eyes than the Early Ohio, will usually require a few more bushels per acre. For the average variety the commercial growers may plant from 16 to 18 bushels per acre.

Planting Small Whole Potatoes

If certified stock is used, small whole potatoes may be cheaper in price, give better stands and higher yields than cut seed. Producers should guard against the tendency to use small and inferior seed, as diseased and unproductive plants produce larger quantities of small potatoes. Other advantages of whole tubers free from diseases are that they may be planted earlier, deeper, and in heavier and cooler soil than cut seed with prospects for satisfactory growth.

Also, as they may increase the stand, they have a particular value where planted for the late crop. Such seed is an inducement, but it is highly important for producers to use certified seed and exercise judgment and discretion in avoiding the use of diseased and inferior seed which is more likely to occur in small whole potatoes than in normal sized cut seed.

Planting

The early potato crop should be planted as soon as the soil is warm enough for germination. When earlier conditions permit planting, the greater the length of time for growth before high temperatures occur. The late crop is usually planted about 6 to 8 weeks after the early crop. If the vines of the late crop are large enough to shade the soil about the base of the plants when hot weather occurs growth and production may be facilitated.

Planting too deeply like planting too early causes slow germination and soil borne diseases may become more serious. Average planting depths on light soils are 3 to 4 inches and on heavy soils $2\frac{1}{2}$ to 3 inches. In fact, for best results some of the most successful early producers plant not more than 2 inches in depth.

Spacing, in general, between the rows is 32 inches for early potatoes and 36 for the late crop. The type of machinery used in cultivating the crop may be considered in determining spacing distances between rows. In the row, the spacing is about 9 to 14 inches for the early varieties and 18 inches for the late crop. To prevent damage by high soil temperatures through increasing soil shading, closer planting is frequently suggested for early potatoes.

Cultivation

Cultivation may start as soon as the plants are above the soil sufficiently to mark the rows plainly. For the early crop, when frost is predicted it is

advisable to withhold cultivation as it may increase danger of injury. The main purpose of cultivation is to prevent weed growth. Good shallow stirrings of the surface soil as the weeds emerge are the most effective. Cultivations may be required as often as once a week or after rains. Each succeeding light stirring or breaking of the soil surface should usually be more shallow and further away from the plants than the previous one to avoid root and foliage injury. Throwing the soil toward the plants and building up slight to moderate ridges may be helpful. The ridges may facilitate the handling of excess water, provide easier digging, increase the efficiency of weed control and toward the end of the season prevent the tubers from sunburning. As the crop reaches maturity cultivation is discontinued.

Straw Mulching Potatoes

The growing of potatoes for home uses under a mulch preferably of clean wheat straw or other mulch materials such as old hay, slew grass, leaves or coarse straw manure is a common practice. The seed pieces are covered with about an inch or two of good top soil. A straw mulch of about 8 inches is spread over the soil just as the potato sprouts begin to emerge.

In dry warm weather moisture is conserved and the tubers are kept cool causing increased yields and higher quality. On the other hand, in wet years yields may be decreased by the decay of seed pieces, delayed maturity may occur and the lowering of the soil nitrates is possible. Cost of production is usually increased and mulching materials may be found difficult to secure.

Irrigation

During growing seasons particularly when rainfall is short and high temperatures prevalent, irrigation properly performed may mean the difference between a profitable crop and one that barely pays expenses or less. Furthermore, in most sections there is rarely a season when irrigation at certain periods would not increase yields and quality.

Only recently has irrigation been seriously considered for Irish potatoes in the eastern, southern, northern and central states areas. There are now many experiment station bulletins and books by competent authors that report the gains by modern irrigation under field experimental conditions. Many of these deal with crops that producers in the past assumed could get along splendidly without extra water. Some of these crops were pastures for dairy herds, meadows for hay crops, sweet corn, practically all vegetable and truck crops, berry crops, orchards and vineyards.

From the many recent publications on irrigation of potatoes, information will be given from one which is, in general, typical of the others. Cornell Experiment Station Bulletin 862, 1950, by Hampton, Murphy and Hoff reports an eight-year average increase in yield from irrigation of 57 bushels per acre or 22 per cent. In only three of the eight years did the gain for irrigation fall below 15 bushels per acre, the amount required to

justify the installation of equipment. In one year the gain was 155 bushels and in another 211 bushels per acre over unirrigated plots.

Irrigating crops and the proper handling of modern irrigation equipment is a specialized undertaking. Furthermore, unless irrigation is performed properly with the type of equipment suitable to the needs, it may prove to be a disappointment.

FIG. 59.—Quick-latching, flexible couplings allow lightweight pipe lines to follow contours. Irregular land need not be graded or leveled. Portable sprinkler systems conform to sloping or rolling ground. Can be used on various kinds of crops. (Courtesy of Aluminum Company of America, Pittsburg, Pa.)

In determining the crop or crops to be irrigated and the type of system to use it is highly important that the local county agricultural agent and the agricultural engineering specialist of the State Agricultural College, one or both, be consulted. Also, irrigation companies have good engineers who are responsible and capable of cooperating and assisting both producers and state employees.

Harvesting and Storage

HARVESTING. Potatoes are harvested for both home and commercial uses from the period when they have reached a size somewhat larger than walnuts until the vines ripen and the tubers mature. A higher price or need for use in the home may justify early harvesting even at some loss in quantity before the crop reaches full maturity. However, it should

be understood that immature potatoes, bruise easily, shrink severely and do not keep well.

Potatoes are dug with hand tools such as spading forks, potato hooks, plows and special machinery designed to do practically all or a part of the digging, cleaning and grading procedures. The careless use of tools or a

FIG. 60.—A commercial potato harvester in operation. (Mo. Agr. Exp. Sta.)

lack of care in handling the tubers, one or both, may result in considerable injury and losses. The skin of newly dug potatoes is particularly susceptible to injury until the surface has dried or cured for a few hours.

Potato grading is a common and accepted practice of successful producers. Tubers too small, ill shaped, showing injuries from diseases and insects or other damage unacceptable for the grade established should not be placed on the markets. Potatoes may be placed in various types of containers and kept in them until used or sold.

STORAGE.—That portion of the crop if any that goes to storage should be of a high grade. A dark storage with relative humidity of 85 to 90 per cent is considered desirable. The resting stage of potatoes lasts for about two months during which time they will not sprout. If for table stock they may be held at 60° F. until near the end of the rest period, when the temperature should be lowered to about 40° F. to prevent sprouting. Potatoes freeze at 26° to 28° F. For seed purposes, the stock is held after harvest about 10 days at 60° F. and then the temperature is lowered. The main object of ventilation is to regulate the temperature. Too much outside air causes shrinkage but adequate air storage circulation is essential.

PIT STORAGE.—Storage pits of various types and sizes are prepared for home uses. Medium sized and large sized barrels are partly buried in the ground and then covered with straw and earth. Natural caves and cellars under the house or connected with it may provide satisfactory storage for home uses. Ventilators are usually placed in the top of pits and cellars at about 4-foot intervals. The temperature of the pit at the end of the rest period of two months should be kept below 41° F. to prevent tuber sprouting. Commercial crops are usually placed in cold storage soon after the rest period is completed. The temperature in cold storage can generally be regulated as desired. If the tubers are held in containers or in piles, a temperature of 36° to 38° F. will prevent sprouting at the bottom of the pile and at the same time prove satisfactory for those in containers if the containers are separated sufficiently to allow for air passages. Additional information on storage may be found in Chapter 25, page 328.

Chemical Treatment to Prevent Sprouting

According to the Missouri Agricultural Experiment Station the sprouting in storage of Irish potatoes and root crops can now be prevented by treatment with a product known chemically as the methyl ester of naphthaleneacetic acid. This new chemical material is non-poisonous and can be used with perfect safety. It is sold in three different forms: liquid, dust, and treated shredded paper. All forms are effective when properly used. In using, make sure the potatoes are relatively clean and that the material is distributed evenly throughout the storage container. Each tuber should receive some of the material but need not be entirely covered as the chemical slowly gives off a gas which is absorbed by the tuber (or roots). One treatment is sufficient for the entire storage season unless excessive air circulation carries the gas away. The potatoes should be treated as they are put into storage or at least before they start to sprout. The chemical will not effectively stop the growth of sprouts that start before the chemical is applied and will not prevent rot. The tubers should be cured in the usual manner and stored as outlined below. A lower humidity may be necessary with the restricted ventilation to prevent condensation of moisture.

The commercial brands of the ester (such as Barsprout, Sprout Inhibitor, Potato Fix, Stop Sprout, Spud-Keep, and others) are usually sold in small amounts sufficient to treat 8 to 12 bushels. The cost is about

10 to 12 cents per bushel. The active ingredients vary with the brand and the specific directions on the container label should be followed. Seed stock should not be treated, as it may not sprout in the spring or fall.

FIG. 61.—The potatoes at the left were treated at the beginning of the storage period, while those at the right had no treatment. It is obvious that chemical treatment prevents waste in storage from sprouting and shrinkage. (Mo. Agr. Exp. Sta.)

SWEET POTATOES

(*Ipomoea Batatas*)

In commercial importance as a vegetable crop the sweet potato has a ranking next to the white potato. It is one of the leading vegetable crops of the South and it is popular as a food product in the North. Sweet potatoes are grown extensively from New Jersey westward and southward. Even in the central and northern bordering states the crop has a rather wide distribution. Some of the chief producing states are the Carolinas, Georgia, Texas, Alabama, Mississippi, Virginia, and New Jersey.

The sweet potato is a native of tropical America and it was used as a food and grown rather extensively before the period of Columbus. A warm sunny growing season lasting for at least four months between frosts even for early varieties is required. The plant is tender to frost and this makes its growing in the North difficult. On account of the long vines produced, it is not grown widely in small gardens. The crop is most popular and in greatest demand generally in late fall and winter although with good storage conditions spring and early summer sales may be profitable.

The Plant

The plant produces rather slender, vine-like stems that trail on the ground and roots at the joints. In the tropical regions, it is a fleshy-rooted peren-

nial but it is extended in home and commercial plantings by means of slips or sprouts. The sweet potato belongs to the Morning-glory and Moon-flower family. Some varieties produce longer vines than others, and some are termed "vineless" because they produce a growth of about two feet in contrast to the usual types that may grow vines 10 to 15 or more feet in length. After growth is well started the vines with their luxuriant leaf growth soon cover, shade and tend to smother out short weed growth.

Propagation of Sweet Potatoes

The chief means of propagation consist of the use of slips and cuttings. Slips or draws are obtained from bedded medium sized sweet potatoes. The roots are placed on a hot-bed covered with about 2 inches of sand, leaf-mold or loose top soil. Loose, warm silt is also used in the extreme South without bottom heat but growth may be slow and uncertain unless weather conditions are favorable. The potatoes should not touch, and sand or soil is usually placed over them to a depth of 2 inches and enough added later to make the covering 3 inches. The bed is kept moist and at a temperature of about 85° F. but reduced after good growth starts to 70° to 75° F. Larger whole roots may be cut lengthwise in the center and placed on the soil of the hot-bed, cut surface down. They are considered more subject to diseases when so treated.

One bushel of sweet potatoes may be sufficient to produce 2000 to 4000 slips, providing the sprouts are pulled two or three times when they have grown to a height of about 4 or 5 inches. Heat for the beds may be supplied from several different sources such as manure, steam, hot water, or flue heated methods. A period of about 4 to 6 weeks is usually required to produce slips 4 to 5 inches in height. Vine cuttings in the South are often made from the first plants set. They may range in length from 10 to 12 inches. The tops of the plants are used in making cuttings and if the cuttings taken are excessive, yields may be reduced markedly. Leaves are removed, except at the tip, and the cuttings are planted in a horizontal position, at a depth of 2 to 3 inches, with only an inch or so of the tip protruding.

DISEASE PREVENTION

Hot-bed Preparation

If the black rot occurs in the crop, remove the soil, sand, manure, etc., before the sweet potatoes are bedded in the spring. All rotted sweet potatoes and any other debris about the framework should be raked together and burned. Sprinkle the framework of the hot-bed with formaldehyde, 1 pint in 30 gallons of water, or with a solution of borax made by dissolving 6 pounds in 30 gallons of water. If possible, obtain the soil or sand for renewal of the hot-bed from uncultivated ground after 3 or 4 inches of the surface soil has been removed.

Seed Treatment

Sweet potatoes used for sprout or slip growing should be free from diseases. Furthermore, the seed should be from rot-free fields. All decayed

roots infected with black rot, soil pox, or other diseases should be removed and destroyed. Seed treatment is practiced to kill disease-producing fungi that may be present on the surfaces of the sweet potatoes. Disinfection will destroy the spores, or germs, adhering to the sweet potatoes, but it will not destroy those embedded in wounds or in decayed spots. The necessity for seed selection and disinfection is evident when one remembers that spores on the surfaces of the potatoes or embedded in wounds can germinate and infect the sprouts. Diseases may be carried to the field in infected sprouts.

Phygon.—For the past two to three years, this new chemical has been tested for treating seed sweet potatoes. Reports show that it has proved highly effective for the prevention of black rot. The sweet potatoes are treated by dipping momentarily in a concentrated solution of 2 ounces of wettable Phygon in one gallon of water.

Semesan Bel.—This fungicide is an organic mercury and it gives good control of black rot, stem rot and scurf diseases. Treatment is made by momentarily dipping the sweet potato roots in a solution of 2 ounces Semesan Bel per gallon of water. The effect of the treatment is similar to that of corrosive sublimate as it delays sprout growth and causes somewhat fewer slips to grow. However, where disease-infected seed is used the injury from seed treatment is likely to be much less than the damage produced by diseases on untreated seed.

Dithane D14.—Treatment is made by dipping the roots momentarily in a solution of two quarts Dithane D14 in 25 gallons of water. The sweet potatoes are treated just before they are planted in the hot-bed. Serious injury is not done to the roots and sprout production has been only slightly reduced. Scurf diseases have not been effectively prevented through treatment with Dithane D14.

Corrosive Sublimate.—This chemical until recently was most generally used for treating sweet potatoes. The roots are immersed for 10 minutes in a solution containing 4 ounces of corrosive sublimate dissolved in 25 gallons of water. The treatment is particularly effective against black rot and scurf.

The main objections to the use of corrosive sublimate are due to its delaying action on sprout production and the lowering of the number of sprouts produced. Wooden or steel barrels which have been painted on the inside with asphaltum paint are used in seed treatment. After the barrels are filled with the roots, the solution is added and the potatoes are allowed to stand covered for 10 minutes. The solution may then be drained off through an opening near the bottom of the barrel and used in treating three or four additional lots of roots.

Where the corrosive sublimate solution is used, about two-fifths of an ounce of the crystals dissolved in a little hot water should be added after treatment of about 10 bushels. The quantity of solution should be made up to the original volume by adding water when needed. After treating 50 bushels, discard the solution and start with a new one.

Borax Treatment.—One pound of borax is dissolved in 5 gallons of water. Where large quantities of roots are to be treated, 6 pounds of borax may be dissolved in 30 gallons of water. As borax dissolves slowly in cold water,

one pound may be placed in one gallon of hot water and stirred vigorously. When the borax is completely dissolved add 4 gallons of cold water. If all the water is heated it should be allowed to cool before treatment.

Soak the roots from 8 to 10 minutes in barrels, other containers or baskets dipped into the barrels. The sweet potatoes should be bedded wet immediately after removal from the borax solution. Several lots of roots may be treated in the same solution as it is not weakened by repeated use. When the amount becomes too small to cover the roots, however, more of the solution should be added.

CAUTION.—Corrosive sublimate is very poisonous. Any sweet potatoes treated with either corrosive sublimate or borax should not be used as food or fed to animals. The solution remaining after the treatment with either material should be carefully disposed of and kept out of the reach of children and animals.

Sweet Potato Sprout Treatment

Sprout treatment is used to prevent infection by disease-producing organisms in the garden or field soil or from the hot-bed. Some promising materials which have been tested on sweet potato sprouts are Phygon, Dithane D14, Wettable Spergon and Semesan Bel.

Phygon.—This product has proved effective in the prevention of black rot. It does not cause injury to the sprouts but is considered somewhat less effective than Dithane D14 for preventing the black rot disease. Treatment consists in dipping the sweet potato plants in a concentrated solution made by dissolving 2 ounces of Wettable Phygon in 1 gallon of water.

Dithane D14.—For the prevention of infections of black rot a 2 per cent concentration in water has proved highly effective. The dipping method is employed. It may cause injury to the sprouts but this has not always proved serious in experimental work. Caution, however, should be observed.

Semesan Bel.—This organic mercurial compound has shown promise as a sprout treatment for the prevention of injury by black rot, scurf, and soil-borne stem rot. Treatment consists of a momentary dip in a concentration of 1 pound Semesan Bel per 10 gallons of water. Sprout treatment, however, has not been considered effective against stem rot and yields have not been as high as with treatments with Wettable Spergon.

Wettable Spergon.—The product is effective for the prevention of soil-borne stem rot when used as a momentary dip at the rate of 2 ounces per gallon of water. It has not been found effective for preventing black rot as a sprout or seed treatment.

Varieties

The varieties have been classified into eight major groups with each group named for the variety considered most typical or representative. The different groups are made up of Spanish, Southern Queen, Jersey,

Florida, Ticotea, Pumpkin, Belmont and Shanghai. The flesh of Puerto Rico of the Spanish group and Nancy Hall of the Florida classification are when cooked soft, moist and sugary and are favored on the southern markets. In the North the Jersey group consisting of the dry and mealy types are preferred. These consist of sorts such as Yellow Jersey and Big Stem Jersey. Furthermore, on the northern markets, Yellow and Big Stem Jersey are important for shipping and handling. Sweet potatoes of soft texture and large in size are often called "Yams." However, this name refers to a species of *Dioscorea* and not to the sweet potato, *Impomea*. Although true yams may be found growing as vegetables in Florida, yet they are not even closely related to the sweet potato.

The Soil for Sweet Potatoes

Any moderately fertile well drained soil in a location with a long growing season may give good results. However, the crop generally grows best in a sandy loam soil. Very rich and comparatively heavy soils have a tendency to grow ill shaped roots and reduced yields. Also, plowing 6 to 8 inches deep may increase the yield of long, slender roots unsuited for market uses. Soils slightly acid appear to be somewhat better for good sweet potato growth than alkaline or neutral ground.

Planting and Cultivating

The spacing allowed for the plants is dependent upon the fertility of the soil and the variety to be planted. Rows are usually 48 to 72 inches apart and the plants are set in the row at distances of 12 to 24 inches. Oversized root production may be reduced by close planting.

For better soil drainage, ridges from 3 to 5 inches high are made by some producers. However, opinions differ as to the value of planting on ridges or on the level. The ridges may give better soil drainage but during dry seasons plant growth may be reduced particularly if the ridges are too high. The sprouts are set on the ridges which are usually spaced about 4 feet apart and firmed by rolling.

Plants pulled from the hot-bed for transplanting should be held in the shade in moist packing materials or in moist soil until planted. In commercial plantings machines are employed in setting the sprouts and some distribute water at the base of the plants as they are set. On small plots the transplanting is done by hand. Such implements as small hand shovels, tongs or dibbles are used in making holes for the sprouts. In machine or hand setting the leaves of the sprouts should be about an inch above the watered or firmed soil when the planting operation is finished. If a small amount of water is poured around the newly set plant before firming the ground, it is usually better to fill the depressions made by the water with soil and omit ground firming.

Watering is generally a good practice particularly in dry periods as it may increase the stand of plants. Vine cuttings are usually taken in the

field and may be pressed into the soft moist soil at once leaving the tips containing the leaves just above ground. Watering as with sprouts may prove helpful.

Considerably less cultivation may be required for sweet potatoes than for other vegetable crops. The vines produced may in a comparatively short time cover and shade the ground sufficiently to prevent weed growth especially in late summer and fall. Until the vine growth interferes with cultivation, the shallow stirring of the soil at regular intervals following rains or irrigation is helpful in keeping down weed growth and conserving soil moisture. Where weeds are somewhat of a problem the pulling of those that push up through the vines after cultivation is stopped may be needed.

FIG. 62.—Planting sweet potatoes with a plant-setting machine. (Kansas Agr. Exp. Sta.)

Fertilizers and Manure

Heavy applications of nitrogen fertilizers may cause strong vine growth and the development of long thin sweet potatoes. Manure is frequently applied in furrows and covered with soil before planting in ridges or on the level. On very thin and impoverished soils the practice may have merit. However, as the sweet potato has the ability to thrive even on soils rated as somewhat poor or thin, manures are less often used. Phosphorus and potash fertilizers are more likely to be needed than manure for this crop. If nitrogen is applied the percentage is generally low. Side dressings of the fertilizers where needed appear to give the best results. Under good culture yields as high as 300 to 400 bushels per acre may be secured.

Irrigation

It is generally known that sweet potatoes will endure successfully more dry weather than most of the other vegetables, yet sufficient moisture for good growth and production is important as with other crops. Irrigation generally gives best results after the plants are set and before the vines completely cover the ground. Also, light applications when needed to supplement the rainfall usually give better results than heavy applications made at rather long intervals. Too much water near the surface causes shallow root production.

Harvesting Sweet Potatoes

If possible harvesting should be done during dry, sunny weather. To meet the early market demands the crop is harvested as soon as the roots reach marketable size, although they may not be mature. The chief crop, however, should not be harvested until the roots are fully mature if possible. Immature sweet potatoes do not cure in a satisfactory manner and are likely to show objectionable dark brown or black spots from cuts and slight bruises.

In sections where frosts occur, harvesting is usually begun shortly before or after the tips of the vines are killed by frost. Material losses are not likely to occur until temperatures fall low enough to damage the root crowns. Should killing frosts come before harvest, the crop should be dug as soon as possible because roots harvested 4 or more days later are almost sure to have a shorter storage period and show a loss in quality.

Roots that are stored for "seed" should always be harvested before killing frosts occur because temperatures below 40° F. may cause the roots to fail to sprout the following spring. However root freezing does not occur until the temperature drops to 29° F.

Commercial growers either purchase or adapt machinery for cutting and removing the sweet potato vines and for digging the roots. Home producers use for cutting the vines such implements as may be available; these may consist of corn knives, brush scythes, reap hooks and other tools. Ordinary plows, listers, spades and hoes are used in digging the roots from small plantings.

To prevent cutting and bruising care in digging, drying, curing, and storing is important. Heavy storage losses may occur from careless operations, due to the development of decays such as surface rot, soft rot and other maladies resulting from rough handling practices. The stems, taproots, and secondary roots are removed from the crop marketed soon after harvest. For the crop that is to be cured and stored it is generally better to withold the removal of these parts as considerable injury may be done. For convenience, the roots from 2 to 3 rows may be piled together on one row for drying. At the end of the day if there is a likelihood of rain the roots are removed and placed in shelter or storage. Slatted crates, aerated boxes, baskets and other types of containers are used in handling. Ventilated containers serve best.

Curing Sweet Potatoes

The chief purpose of curing is to hasten as rapidly as possible the healing of wounds on the roots and facilitate the thickening of the skin to supply protection against the entrance of rot producing diseases. Following harvest sweet potatoes are kept in storage rooms having a moist atmosphere to slow down the loss of moisture and promote the healing of cuts and bruises. Just enough ventilation is allowed to prevent the formation of drops of water on the roots and walls of the storage rooms.

When the roots are held at a temperature of 80° to 85° F. with 90 per cent relative humidity, satisfactory healing may be completed in about 10 to 14 days. Naturally, if the temperature and humidity, one or both, are lower, longer periods of curing will be needed. Healing of wounds is stopped at 50° F. and it is going slowly at 75° F. or lower.

In most sections where sweet potatoes are produced on a commercial scale, artificial heat is required in the curing process following harvest. The Puerto Rico variety, however, is cured and stored effectively in southern Louisiana without the use of heated storage houses. In other similar areas, where the sweet potatoes are harvested in October and stored in warehouses enough heat is supplied by the potatoes to make the use of artificial heating unnecessary.

Storage

Soon after the curing period is finished, the temperature of the enclosure should be reduced slowly within 2 or 3 days to about 55° F. and held as nearly as possible at this point for the storage period. Lowering the temperature quickly may cause damage to the roots through the condensation of moisture on them and in the storage room. Should the temperature be permitted to fall to 50° or 40° F. or lower, injury and decay follows fairly rapidly. A storage temperature of 60° F. is likely to give better results than 50° F. although 60° F. may cause some sprouting and shriviling of the roots. A rather high relative humidity should be maintained throughout the storage period. The potatoes are not handled in storage, in order to avoid the spread of rot. Varieties may differ materially as to keeping quality and length of marketable storage. In most instances the best source of information on such problems is the State Agricultural Experiment Stations.

Storing for Home Uses

Sweet potatoes may be cured and stored in a warm building or room where the air is dry and the temperature uniform. Boxes, crates, bins, and baskets are used as containers. It is important that the containers be so arranged as to provide ventilation. Heat is required when the temperature falls to 48° F. or lower. If it rises to 60° F. ventilate to lower the temperature to near 55° F. when the ventilators may be closed. Pits, caves and banks do not provide facilities for curing and ventilation and the losses in such storage places may be heavy. Drier and warmer storage with at least some provision for ventilation is needed. Since there is danger of spreading diseases by handling the potatoes in storage, the roots should be disturbed as little as possible.

Chapter 21

Solanaceous Crops—Tomato, Eggplants and Peppers

SIMILAR handling and cultural practices are adopted in the growing of the tomato, eggplant and peppers. The potato also belongs to the Solanaceous family but it is generally listed as a tuber crop and it was discussed in an earlier chapter. In the northern sections, particularly, these crops may need most of the growing season for good cropping and the plants are usually killed by the early autumn frosts. They are similar to the vine crops in demanding warm seasons for good growth and in being sensitive to injury by cold and light frosts. All are started from seed, usually under some type of cover such as cold frames, hot-beds and greenhouses and are later transplanted to the garden or field. The production of heavy crops is usually dependent upon an early start with healthy stocky plants. Also, there is a need for a continuous rapid early growth and this is usually met by applying fertilizers at transplanting time or soon after growth begins.

TOMATO

(*Lycopersicon esculentum* var. *commune*)

The tomato is surpassed in value among the vegetable crops only by potatoes and sweet potatoes. For popularity and extensive use in all types of vegetable growing the tomato has the highest ranking. This is due largely to its ease of culture, cheapness as a food product, the delightful and distinctive flavor of the fruit in the fresh, canned and preserved state. Its high rating in health-giving qualities is common knowledge. Tomatoes also are of first importance as a canning crop.

Influence of Climate

The climate may have a very important effect upon the varieties that should be planted throughout the states and in the commercial growing districts. Some reliable sources of information are the the county agricultural agents, Agricultural Experiment Stations, other state and federal employees, local growers and seedsmen.

In most instances it is inadvisable to set plants in the garden or field until all danger of frost is past. However, when plants have been grown at home and the supply is plentiful or may be secured at reasonable prices,

growers sometimes take chances on protecting the plants from frost injury or on planting again should damage occur. If flower clusters are subjected to low temperatures when small, the quality of the harvest may be lowered by development of roughened and ill-shaped fruits.

The different varieties require from 80 to 120 days from seed to fruit ripening. However, as about a third of the time may be spent under glass in preparation for transplanting, the actual period of growth outside or in the open is comparatively short. Under good growing conditions the plants may continue fruit production until autumn frosts occur.

Soil and Its Preparation

The tomato may thrive on a wide range of soil types. For high yields a fertile and well drained soil is required. The so-called warm soils consisting of sandy and sandy-loams having a south or southeastern slope are often well suited for the growing of early market tomatoes. Heavier soils may be used for later harvests and they may produce higher yields. Soils that are too rich may cause extensive vine growth and light fruit sets. Fluctuations in the soil moisture supply should be prevented by irrigation or by retaining more rainfall through an adequate soil organic matter supply and cultural practices. A fine, firm, plant bed is a requirement for early growth and high production. The extra work needed for thorough soil preparation for planting usually pays good returns in quality fruit and profitable yields.

Value of Crop Rotations

Regardless of the district, soil type, or variety planted, a suitable crop rotation preceding tomatoes is recommended. Furthermore, tomatoes should not follow potatoes, eggplant or peppers in a rotation because these crops are closely related as they belong to the same botanical family. To do so might cause a build up of diseases common to the group. Weeds such as the horsenettle, pokeweed, groundcherry and others closely related to the tomato are likely to carry virus diseases of the tomato. Fields infested by these weeds should be planted to other crops for a few years before planting tomatoes. No oftener than once in five years should a crop of tomatoes be grown on the same soil.

A crop rotation system for a four- or five-year period using small grains, legumes, unrelated vegetables and other crops that will meet the needs in every section or district may be developed without too much difficulty. In so doing and through the judicious use of commercial fertilizers and manures the humus content and fertility of the soil may be improved materially for tomato growing. Where manure is unavailable, a rapid turnover of soil organic matter may be made by plowing under green manure crops. Some of these may be cowpeas, soybeans, hairy vetch, wheat, rye, barley, buckwheat and other crops.

Commercial Fertilizers and Manure

To meet the plant needs and soil requirements, the fertilizer test is now considered one of the best guides for making fertilizer recommendations.

The county agent may be able to help growers make arrangements for this service. It is important to know whether the soil has been depleted or if a soil building program has been followed.

Applications of fertilizers depend upon such factors as spacing of the plants, methods of use, and the make-up of the fertilizer. Soils deficient in organic matter may be improved materially through the use of from 10 to 20 tons of rotted manure supplemented with 500 to 800 pounds of superphosphate or a complete fertilizer high in phosphorus. Nitrogen is often applied as one or more side dressings. A plant "starter" application may consist of a complete fertilizer like 5-10-5, or 8-8-8 or some other similar combination. An application at the rate of 200 pounds per acre may be made at planting time or soon after in a single or double band, 3 or 4 inches from the plants and about 4 inches deep.

After the first fruits set, a side dressing of about 60 pounds of ammonium nitrate or its equivalent per acre is suggested. On many soil types another side dressing made at the same rate about three weeks later may help in extending the fruiting period particularly if the rainfall is ample or irrigation is available. Disease control must accompany such fertilizer applications for profitable results.

Plant Growing

Tomato plants for commercial and home uses are secured from several sources. Canning companies produce and distribute them to their growers. Dealers buy from plant growers and supply the needs of home producers and others. In market gardening areas many growers may raise their own plants.

In the middle states and northern sections, tomato plants are started in plant structures such as hot-beds, coldframes, and greenhouses about 5 to 8 weeks before transplanting in the field. Outdoor plant beds are established in the southern growing regions and through the use of chemically treated certified seed and the spraying of plant beds, high quality plants are available.

Greenhouse Plants. – After seeding in flats or beds in greenhouses, the seed is covered with a thin layer of fine soil mixed with sand and the temperature is held at 70° to 80° F. at the beginning period. When the second leaf appears, the plants are thinned or reset at a distance of $1\frac{1}{2}$ to 2 inches apart. They may be moved and thinned once or twice more and at transplanting time they may stand 3 to 6 inches apart. It should be emphasized that overcrowding or a lack of sunlight produces spindly plants which are unsatisfactory for setting in fields and gardens. The earliest blooming and fruit setting plants are the stocky and well-branched ones.

Use of Hot-beds and Coldframes. Hot-bed and coldframe methods of plant growing are much like those of greenhouses. After about two weeks in the hot-bed, the plants may be ready for shifting to coldframes where they may be set 3 inches apart each way. They may remain here until transplanted outside. Also, the seed may be sown thinly in hot-beds or coldframes and the plants moved directly to the field or garden without transplanting.

Open Seedbeds.—In New Jersey, Virginia, Maryland, Delaware and other southern areas, open seedbeds are established in early spring. The seed is sown when the ground has warmed, about 5 to 6 inches apart in drills or rows 12 to 14 inches apart. The chief objection to this method is that the plants cannot be grown and made available for early plantings and demands. However, the method may produce large numbers of plants at a low cost. The method may be unsuited for short growing seasons but favored for late market crops of quick maturing varieties and for long growing seasons.

Hardening Tomato Plants

Hardening of the plants for transplanting is an old practice. It is accomplished by growing for a week or more at cool temperatures with good ventilation or by withholding water, one or both. The plant is stunted and slowed up in growth. If the method is overdone it promotes lower early yields and the development of rough fruit. It is generally safest and best to delay setting in the open until all danger of frost is past. When this is done little or no hardening of plants may be needed.

Planting Operations

Mechanical Planters.—For large acreages mechanical setters on well prepared seedbeds are being used extensively. The equipment providing for watering the plants is a great advantage as the percentage of plant survival is generally higher than in hand setting without watering. The machines may not be able to set plants deeper than about 5 to 6 inches. Long rows and large acreages of fairly level land including well prepared seedbeds are needed for the economical use of mechanical equipment. Transplanting machines are also limited to the setting of seedlings with little or no soil on their roots.

Hand Setting.—All sizes of plants should be planted fairly deep for good results. Hand methods are adopted for setting blocked or potted plants in order to retain the soil around the plant roots. If the plants are longer than 12 inches, hand setting is required. Small or medium sized plants are often set rapidly by means of a pointed stick about 12 to 14 inches in length and known as a dibble. If the planting work can be done on cloudy days in fairly moist soils much may be gained in plant survival. For dry soils in windy and sunny weather a little water placed around each plant after firming the ground about the plant base is in most instances required.

Starter or Nutrient Solutions

Nutrient Solutions.—For a good plant survival or stand, water at the rate of ½ to 1 pint to each plant is advised wherever possible. Nutrient solutions such as one consisting of 20 grams Ammo-Phos A and 10 ounces of nitrate of potash in 50 gallons of water and another solution of 3 pounds diammonium phosphate in 50 gallons of water have attracted wide and favorable attention especially on soils low in available phosphorus.

Nitrogen fertilizers are often applied as a "starter" and followed by one or more nitrogen side dressings. A complete fertilizer such as 5-10-5, or 8-8-8, or a similar analysis may be used. Apply at the rate of 200 pounds per acre in a single or double band, 3 to 4 inches from the row and about 4 inches deep. Make this application either at transplanting time, or immediately following. When the first fruit sets, side dressing with a nitrogen fertilizer to furnish approximately 20 pounds of nitrogen per acre may be used. This application would be equivalent to about 60 pounds of ammonium nitrate per acre. A second side dressing, applied at the same rate about three weeks later will generally help extend the fruiting period if rainfall is sufficient or irrigation available. Satisfactory disease control must accompany the fertilizer program for good cropping.

FIELD AND GARDEN SPACING.—The chief factors determining spacing are the variety, soil, season, and whether the plants are staked and pruned. In general, the plants are set about 4 to 5 feet apart. However, closer and wider spacings are used. Delays in ripening, reduced size of fruits, and occasionally fruit rot may result from close spacing. If set too far apart little or no protection from wind and sun is given from adjoining plants.

Usually under normal seasonal conditions, early varieties may be given wider spacings than late varieties. Rainfall, the accumulation of extra soil nitrogen, and other factors may reverse conditions and cause the greatest growth in late summer and fall in some sections. Late shipping and canning crops particularly in California may be set 6 × 6 feet or even 6 × 8 feet. In large plantings if driveways are spaced about every 8 to 10 rows apart, transporting and handling fruit and equipment may be facilitated.

Plant Protection

For use every year, plant protectors are of doubtful value due to the variability of weather and insect attack. The protectors are used by some growers to prevent wind damage, injury from very light frosts, and against insect injury. The so-called hotcaps maintain a higher temperature inside the protector during the day. Unless good ventilation is provided by cutting the protector on the side opposite the prevailing wind, soft, weak plants may be grown. The opening made can be enlarged as the plant grows and the hotcap finally removed when it has served its purpose.

Cultivation

Shallow cultivations after rains and each irrigation are a common practice. After the first one, each one that follows should be a little farther away from the plants to avoid injury to the roots. The practice is performed no more often than needed to control weed growth. When the vines have covered the row, cultivation should be stopped.

Mulching

Straw mulches are sometimes used to cover the ground when the tomato plants reach a height of about 12 to 15 inches. They are usually more valu-

able in dry than wet years. The practice may have the greatest appeal to home gardeners for limited areas where less difficulty may be had in securing mulching materials. The mulch keeps the vines from coming in contact with the soil and it may reduce the amount of spoiled fruit.

In dry seasons, blossom-end rot troubles may be made less severe, and the mulch conserves soil moisture. However, mulching slows up growth and delays maturity and the fruit size may be somewhat lessened. To prevent the foliage from turning yellow and showing nitrogen deficiency, an application of a nitrogen fertilizer should be applied.

FIG. 63.—Mulched tomatoes producing an excellent crop in the home garden. (Mo. Agr. Exp. Sta.)

Irrigation

In some sections growth and production are dependent upon irrigation. For other areas it may supplement the rainfall to an advantage. All will usually agree that for the tomato, enough water should be applied during the season to keep the plants growing continuously but moderately. Such factors as soil organic matter, soil type, slope of ground, and climatic conditions generally determine to a considerable extent, the frequency and number of irrigations needed.

Overirrigation at any time and particularly from transplanting to fruit setting is usually harmful. Regular and uniform applications as needed are best. Heavy irrigations may tend to produce soft, light colored fruits, retard maturity of the crops, increase fruit cracking and lessen yields. After fruit ripening starts the crop should be brought to maturity with the minimum amount of water for satisfactory growth and fruit development.

Pruning and Staking

Whether to adopt pruning and staking as a cultural practice is an undecided question among market gardeners and commercial tomato growers. As many as five or six different styles or types of handling the work to meet the varying problems are employed. The method is still practiced, however, in a considerable number of states scattered over the important tomato producing sections of the United States. The arguments that may be given for and against staking and pruning when weighed and considered are generally found to be about equal in value.

The advocates of the method list these advantages: There is less fruit decay because of no contact with the ground; somewhat more early ripe fruit is possible; cultivation and harvesting is facilitated; cleaner, firmer and perhaps a little larger fruit is produced. On the other hand, the main drawbacks are increase in cost of labor and materials; the development of additional fruits affected with blossom-end rot; increase in the cracking and sunburning of fruits, and a total somewhat lessened crop yield.

As more plants may be grown in a given space if staked and pruned, the practice naturally appeals to many home gardeners. When pruned and trained on supports, tomato plants may be set 18 to 24 inches apart and in rows 4 feet apart as compared to unpruned plants having a spacing of 4 × 4 feet. There is always danger of severe damage by sunscald when plants are subjected to open and direct sunlight.

Varieties of Tomatoes

There are many varieties of tomatoes but only a few are important. Perhaps no other vegetable crop shows a wider difference between strains of the same variety than does the tomato.

Earliana is a very early red fruited variety with several strains varying in size and smoothness of fruits. Prichard is a little later but it has better quality than Earliana. Bonny Best another early sort is grown extensively as a home and market garden variety, and it is canned to a limited extent. Globe, a pink colored tomato is grown chiefly in the southern sections as a shipping variety. It is also used widely for home and nearby markets in the Cleveland and Detroit areas and elsewhere where extensive areas are under glass. Gulf State Market, pink in color, is grown mainly in the Gulf States for shipping in the unripe state. Marglobe, with red fruits, has a wide use for canning and shipping because of its resistance to Fusarium wilt. The fruit ripens unevenly and is subject to cracking. In the eastern and middle western states, Rutgers is the most important canning tomato and it is popular as a home garden and fresh shipping variety.

Such varieties as Greater Baltimore and Stone are leading canning sorts east and south of the Rocky Mountains. They are not well suited to conditions of the northern states. Santa Clara Canner is a central and northern California kind used for canning and to some extent as a home garden variety. Due to the requirements of a long growing season, high temperatures, and a fertile soil it does not thrive well east of the Rockies. Mingold.

Golden Queen and Jubilee are ranked among the best yellow varieties. Some home gardeners have a preference for large fruited sorts like Ponderosa and Oxheart.

Disease Resistance.—It is important in practically all sections that varieties adapted to the requirements be resistant to the Fusarium wilt disease. Some of these are Rutgers which is often a favorite on the fresh fruit and vegetable markets and for canning. Stokesdale is a good yielder and disease resistant but the fruit runs small on light soils and it may not produce sufficient foliage for fruit protection. Break-O-Day is a leading early variety for staking. Other varieties appreciated for their disease resistance are Prichard, Marglobe and Greater Balitmore. There is an ever increasing interest and demand for varieties for commercial and home uses that are disease and drought resistant and that possess good size, color and smoothness. Varieties are available that are resistant to other diseases such as anthracnose, leaf mold, late blight, etc.

Harvesting

The tomato fruit being highly perishable and tender requires intelligent and careful picking and handling. In determining the time to pick, such factors as temperature, rainfall and vigor of plants should be considered. The gathering of fruit of the proper color and stage of ripeness for markets and home uses requires considerable study, practice and a keen interest in the work. To meet market demands careful supervision and direction of labor by competent foremen is required in picking, grading and packing operations.

Insect and Disease Control

General information and suggestions for the control and prevention of damage by insects and diseases may be found at the close of Chapter 24.

EGGPLANT

(*Solanum Melongena* var. *esculentum*)

In the United States the eggplant is not grown widely except in a few sections either as a commercial vegetable crop or for home uses. However, interest and appreciation for the crop is on the increase. In such countries as Japan, China and India it ranks as one of the most important vegetables. Also, in the Balkans, the countries bordering the Mediterranean Sea, France, and elsewhere in Europe the eggplant is a stable vegetable or highly prized as a wholesome food product.

Climate and Soil

As a continuous rapid growth is required, a long warm growing season is needed for good production. The plants should not be set in fields or gardens until the soil is warm and all danger of frost is past. Loose friable,

deep and fertile soils give the best results. Sandy loams containing ample quantities of organic matter should be used if possible.

Manures and Fertilizers

Crop rotations, use of manure or green manure crops and soil building practices suggested for growing profitable crops of tomatoes, should in general be well suited to eggplant culture. Enriched soils through such practices may be still further improved for the crop by applying from 500 to 1500 pounds of a high analysis fertilizer, having adequate ready available nitrogen.

Fig. 64.—The eggplant is a popular vegetable that requires little space. (Photo by Bureau of Plant Industry, Soils, and Agricultural Engineering, U.S.D.A.)

Plant Production

About eight weeks before the frost-free date, the seed is planted under glass. As the seedlings are comparatively slow growers, a fairly rich soil is needed. For the first transplanting under glass, pots or other plant containers are suggested. Now and then a watering consisting of a nitrate solution or liquid manure may prove helpful.

Planting Outside

Although time for setting may have arrived, if the plants are not crowded and satisfactory growth is being made, it is often advisable to hold the plants a few days longer or until favorable planting weather occurs. Spacing and cultivation practices are similar to those suggested for tomatoes.

Varieties

Black Beauty is a leading variety. Badger State and New Hampshire Hybrid are a little smaller in size but are earlier. Blackie is the earliest and smallest sort. A popular midseason variety is Long Purple. Late varieties of the high-bush type, are Fort Myers Market and Florida High Bush.

PEPPER

(*Capsicum frutescens* var. *grossum*)

The common garden pepper is produced for the pod, which is used in both the green and ripe stages of development. Mild-fleshed types are used for baking, stuffing, salads and pickles. The stronger or more pungent types are used for relishes, seasoning, sauces and pickles. These peppers are different and distinct from the black and white peppers of commerce which come from a tropical woody plant (*Piper nigrum*).

Climate and Soil

Peppers will thrive under a wider range of temperature and moisture than tomatoes and eggplants. In fact, prolonged high temperatures may cause poor sets of fruit. Soils similar to those described for the other Solanaceous crops are in general satisfactory for pepper culture. Light soils of the sandy or silt loam types giving good soil drainage, containing ample supplies of humus and retentive of moisture are considered best. Commercial fertilizers such as 4-12-4, 5-10-5 and other formulas used at the rate of 1000 to 1500 pounds to the acre, may supplement the fertility of good soils and increase production materially.

Plants and Culture

The production of pepper plants for transplanting does not differ widely from the suggestions given for tomatoes. Furthermore, planting operations, and cultivation are so similar that repetition here seems unnecessary.

Varieties

Such varieties as Windsor A, Early Giant and Worldbeater are large-fruited. Smaller but earlier sorts are Harris' Earliest and Nepolitan. The California Wonder types are valued for their thick flesh. Some canning varieties are Sweet-meat, Perfection, and Glory. A few pungent pepper varieties are Long Red Cayenne, Tabasco, Creole, Red Chili, Red Cluster and Red Cherry.

Storage

Like tomatoes, green peppers may be ripened artificially but a longer period is required. From about 71° to 77° F. is considered the best ripening temperature. At 32° F. peppers may be kept in good condition for about 30 days or more. A relative humidity of 95 to 98 per cent is advised.

Chapter 22

Cucumber, Muskmelon and Watermelon

THESE crops belong to the same family, Cucurbitaceae, and all have similar growth and production requirements. The relationships are close enough to cause the same insects and diseases to attack all the crops. Naturally and logically cultural practices for the group are in general comparable. Handling and marketing practices may differ and in some instances unlike cultural methods may be needed.

These vegetables are very susceptible to injury by cold and frost. To obtain early maturity and increased yields, seeds are often started in hotbeds or greenhouses about 4 or 5 weeks before the period for setting in the open. Separate male and female blossoms are produced on most of the plants, some muskmelons and watermelons, however, may develop both perfect and imperfect flowers.

CUCUMBER
(*Cucumis sativus*)

As one of the important vegetable crops, the cucumber is grown widely in the United States for a variety of different purposes. Some of these are for home garden needs, market gardening requirements, as a forcing crop toward the North and for extensive use as a special crop to be processed by pickle factories. The crop is valued highly in southern sections and is grown rather widely for shipment by trains and trucks to the northern markets. The cucumber is not rated highly for its food value, but it is appreciated from home gardens and sought on the markets for its distinctive tastes and flavors in the fresh state and in the various uses to which it is put after processing.

Where Grown

In the home garden, the cucumber is grown widely throughout the country. For a plant as tender to cold as this vegetable, it merits distinction for such extensive growth under glass and in the open. Some of the leading states in production are Michigan, New York, Wisconsin, Florida, and Illinois. Still other states that rank high in cucumber growing and make up a long list without naming them all, are New Jersey, Ohio, Pennsylvania, California, Indiana, Colorado, South Carolina, Maryland, Massachusetts,

Virginia and Texas. Surely, nearly all will admit that this is an imposing list of states widely distributed and that it speaks "louder than words" for the "lowly cucumber."

Climate and Soil

The cucumber being a warm season crop is subject to injury by cold and frost and it is not planted in the open, generally, until all danger of frost is passed. However, it requires a comparatively short season of growth to bring its fruits to marketable size and use. Warm soils are needed at planting time, as soil temperature above 50° F. are required for seed germination. Late, cool, wet summers are usually conducive of slow and poor seed germination and thin or unproductive stands of plants.

While cucumbers may be grown on many different soil types, good yields and profits are produced on the best soils available. Earliness is usually a first consideration and a sandy or sandy loam soil especially on southern or eastern slopes promote earliness. If large yields are more important than earliness, heavier soils increase yields and prolong the bearing period. For both late and early crops good soil drainage and aeration are a requirement. Soils retentive of moisture because of ample quantities of soil organic matter are desirable as they tend to facilitate an adequate and uniform growth from seed germination to harvest time.

Manures and Fertilizers

If manure is available at reasonable prices, it may be applied to the soil about a year before planting cucumbers with prospects for good results. As much as 15 to 20 tons per acre may be used. The plowing under of green manure crops, particularly legumes, constitute splendid substitutes for manure. Cucumbers respond well to applications of commercial fertilizers either with or without manure. A formula such as 5-10-5 or a comparable one used at the rate of 500 to 700 pounds to the acre may prove helpful. Also, side dressings of a nitrogen fertilizer at moderate rates generally increase yields.

Seeding and Spacing

Seeding in the field or garden is delayed until the soil is warm and danger of frost occurrence is over. Since the plants make a heavy or luxuriant growth adequate space should be provided. Liberal amounts of seed are sown to give a good stand of plants and plant thinning practices are performed later to reduce the number of plants to the spacing distances desired. The final thinning is usually delayed until the losses from the cucumber beetle attacks are past.

In commercial plantings the drill method is generally employed as it is easy to perform and meets the needs best. Seed is sown thinly in the row or about 5 to 7 inches apart and the rows are spaced 3 to 6 feet apart. The plants may be finally thinned to about 12 to 24 inches apart.

For hill planting, the spacing between hills ranges from 4 × 5, 5 × 5, 3 × 6 or at distances that meet the needs of soil fertility and growing

conditions. The average number of seeds per hill is about 5 to 7. After the plants push through the soil and the danger from cold, wind and beetle attack are past, one or two thinnings are made to finally give 2 to 3 plants per hill.

Cultivation and Irrigation

Frequent shallow cultivations are usually required to destroy weed growth and prevent crusts and cracks forming on the surface of the soil. When cultivation may injure the vines the practice should be discontinued. Some weed pulling and hand hoeing may be required later to keep down large weeds and loosen the soil in the row between the plants.

Irrigation may not be needed every year in the humid sections but where facilities are available for its use, it may mean the difference between a crop and no crop. Moreover, cucumbers are likely to receive greater benefits from supplementary irrigation than muskmelons and watermelons. When the plants begin to show leaf wilting and browning of the foliage due to drought injury, water should be applied and continued at intervals as required for good growth and production until rains come and are adequate. After the marketable stage of the fruit is reached, irrigation is usually discontinued.

Varieties

Slicing Type.—With few exceptions the fruits of these varieties contain white spines. The fruits are comparatively large but retain their green color for long periods. They may be used for pickling but pickling types are usually superior and are grown for processing. The most promising varieties of the type are White Spine, Straight 8, Long fellow, Clark Special-A & C, and Black Diamond.

Pickling Type.—These varieties are characterized by being largely black spined, very productive, somewhat smaller fruited than the slicing types, and the green color is not so persistent. If the fruits become too large for pickling they are often used for slicing although other varieties are better suited to this purpose. The chief pickling sorts having certain advantages in some instances for special pickled products are Chicago Pickling, Boston Pickling, National Pickle, Snow Pickling, Early Russian and Mincu.

Greenhouse Forcing Type.—This group consists of varieties adapted to forcing conditions. They may include the long English kinds and others capable of setting fruit without pollinization and fertilization. English types consist of such leading varieties as Telegraph and Rockford Market which are usually capable of setting fruit without fertilization. The Davis Perfect and others of the class are hybrids between the field varieties and the English type.

Novelty Type.—The plants of this group may not be true cucumbers. Furthermore, they may not have commercial importance or value. The fruits and vines produced may be ornamental in appearance or they may have such fantastic growth characters as to be called curiosities. In fact, the names of the members of the group may give a clue as to their forms,

shapes and appearances. A few are: Chinese Three Feet, Snake, Crystal Apple, White Wonder, Lemon, African Horn, and Japanese White.

Harvesting

When marketable size is reached the fruits are cut from the vines. In so doing, harvesting every day or every other day may be required. With the maturity of a considerable percentage of the fruits yields may be reduced markedly Quality fruits are firm, crisp and have developed tenacious seeds. Inferior fruits known as nubbins, ill-shaped specimens and light colored ones should be discarded.

Cucumbers are picked by hand and care is taken to avoid injury to the vines. A short piece of stem is left on each fruit. For whole pickles very small sizes, straight and uniform in size are desired. For dills, sizes up to $5\frac{1}{2}$ inches are in demand. Slicers meet the demands by being straight, dark-green, smooth, uniform and about 6 to 10 inches long. Good yields average about 100 to 150 bushels per acre for marketable lots. Pickling sorts will run about 75 to 100 bushels per acre.

MUSKMELON

(*Cucumis Melo* var. *reticulatus*)

Usage has caused the term "cantaloupe" to be applied to all muskmelons. In the United States, the name is used in trade to designate the small type of netted melon that is shipped in crates. It is the predominating type of melon grown in America. However, some types of muskmelons are not cantaloupes. The kinds that do not fall into the so-called cantaloupe group are the winter types, such as Honey Dew, Honey Ball, Persian and Casaba. Montreal Market and Bender are large ribbed kinds. The true cantaloupe comes from Cantaloupo, Italy. It possesses a hard rind which is worty or rough and often deeply furrowed on the surface. It is seldom produced in America.

Where Grown

The muskmelon may be grown in every state in the Union, yet the commercial crop is produced in about twelve to fourteen states. The acreage in the different states may vary considerably from year to year. Although sizeable quantities of muskmelons are grown for local markets, the major portion of the commercial crop is produced in a relatively few regions which are particularly well suited to its culture. Furthermore, in most instances these areas are located at rather long distances from the chief markets. More than half of the total shipments, according to the records, may for a series of years come from California. Other leading states, however, are Colorado, Arizona, Arkansas, Maryland, Delaware, Indiana, North Carolina, South Carolina, Georgia, New Mexico, Michigan and others.

Climate and Soil

The muskmelon requires a warm growing season with a long frost-free period. The most rapid growth is made in midsummer and late summer when climatic conditions are most favorable. As the nights become cooler the fruits usually ripen slowly. The foliage of the plants is tender and easily injured by late spring or early fall frosts. During the fruit ripening period, dry and sunny atmospheric conditions are needed for the development of a high sugar content.

The soil requirements although important are of less consequence than climatic conditions. The sandier types of soil are usually preferred because of earliness. The heavier clays, when improved by applications of manure or the turning under of green manure crops, may give splendid results. Fall or early spring plowing is suggested and frequent harrowing in the spring until planting time to conserve moisture is usually helpful.

FIG. 65.—Inspecting cantaloupes in a commercial field in Southeast Missouri. (Mo. Agr. Exp. Sta.)

Manures and Fertilizers

Soils well supplied with humus are very desirable for muskmelon culture. Crop rotation systems including the use of manure or green manure crops and applications of commercial fertilizers, should prove desirable. Some experiments have shown that quantities of manure as little as 2 or 3 tons per acre under the hills may give a greater yield and net profit than 16 to 20 tons broadcast. Other tests have shown that a 3-12-4 commercial fertilizer applied at the rate of 300 to 600 pounds an acre produced practi-

cally as large yields as manure applied at the rate of 16 to 20 tons to an acre. All agree that the humus content of the soil should be maintained by plowing under green manure or cover crops. In fact, green manure and cover crops are used to maintain soil organic matter and not as substitutes for manure.

Seeding and Spacing

In the northern sections, the risk of producing a paying crop may be reduced markedly by starting plants under glass and transplanting to the field at the proper time. For outside conditions seedings are made in hills 4 × 6 feet apart with the hills about the same distance apart and in drills 6 feet apart with the plants thinned later to about 2 feet. Since seed germination does not occur below 50° F., it is essential that seeding be delayed until the soil is warm enough for good germination.

TRANSPLANTING.—Seed for growing plants to set in the field are started under glass about 3 to 4 weeks ahead of the time for field seeding. Plantings may be made in wood veneer bands, berry boxes, paper bands, boxes, clay pots, jam cans and other utensils. Holes should be provided in the bottom of all seed containers to give water drainage. Several seeds are planted in the receptacles and at planting time thinning to 1 or 2 plants is the practice. In transplanting to the fields, the bands and containers that may soon disintegrate may be left around the plants.

HILLS.—This system may save some labor in cultivation. A planter or hoe is used in seeding the hills. With the rows 4 to 6 feet apart and the hills nearly the same distance apart in the row, as many as 8 to 10 seeds are planted in each hill. For dry regions the planting depth is 1 to $1\frac{1}{3}$ inches and in humid districts $\frac{1}{2}$ to 1 inch. The soil over the seed should be carefully firmed.

DRILL ROWS.—A drill or seeder dropping seeds 2 to 3 inches apart in the row is frequently used. For good stands of plants it is important that the seed be covered no deeper than 1 to $1\frac{1}{3}$ inches.

Cultivation and Irrigation

Shallow cultivation at intervals often enough to destroy weeds and keep the surface soil loose and retentive of moisture is advised. When the vines have grown to a length of $1\frac{1}{2}$ to 2 feet cultivation may be discontinued. Some hand hoeing may be required after cultivation ceases. Moving the vines lightly to permit better cultivation and irrigation may be justified providing the vines are not left upside down, as newly set fruit may be injured by the sun.

In arid regions irrigation may be a major practice and even in humid districts it may supplement to advantage the rainfall. Light irrigations as growth begins may be adequate. However, as the growth becomes greater and the needs of the soil for moisture increases heavier irrigations are usually helpful. Growth stoppage and the wilting of vines should be prevented at all stages if possible.

Varieties

Popular varieties for long distance shipments are found in the Rocky Ford group. Some of these are Perfecto, Superfecto and the strains of Pollock. Another well known group is Hearts of Gold. Hale's Best is rated highly for earliness and thickly netted fruits with deep, firm, golden colored flesh. Also, related strains are the leading commercial types. Varieties that retain good quality in the overripe conditions, and satisfactory shipping ability for nearby markets are Tip Top, Bender, Surprise, Burrell's Gem, Iroquois, Lake Champlain, and Hackensack. Winter melons requiring a long growing period and those generally produced widely in California are Honey Dew, Honey Ball, and Persian.

Harvesting

To be able to pick melons of any kind at the proper stage of development for long distance shipments is a real accomplishment. To become successful a careful study of all the characters that should be considered must be made. Some of these maturity or ripening characteristics are ease with which the melon may be separated from the vine, general appearance as to netting, ground color and odor. The netting of the melon should always be well developed before harvest.

Much is often written and said about the "full slip" and "half-slip" in picking muskmelons. If under moderate pressure of the thumb against the stem near the melon causes the melon to separate readily from the vine leaving a smooth circular depression on the melon, the full slip or ripe stage has been reached. Where only about one-half of the stem separates easily, the stage of ripeness may be referred to as "half-slip." The proper picking condition is rather difficult to determine by the "half-slip" alone, and careless workers may pick many melons entirely too green for the development of good quality. Through a careful examination, however, and study of the "half-slip" in connection with good netting of the melon, slight change of ground color toward a tinge of yellow including a consideration of size and firmness, may enable the picker to do a satisfactory job in picking melons for distant shipments.

For home uses the full ripe stage should be attained and the local markets may be served without difficulty with melons near the full ripened stage. However, if the flesh becomes too soft melons do not handle well, and harvesting usually is done somewhat before maturity is reached. Fruit from dead vines is likely to be tasteless and worthless. Melons picked at the full slip stage will attain as good quality, if not better, than those which are allowed to become full ripe on the vines.

WATERMELON
(*Citrullus vulgaris*)

As a market crop in the United States, the watermelon is grown widely. A few of the areas noted for heavy production are Georgia, Florida, South

Carolina, Texas, Oklahoma, Missouri and California. According to the Bureau of Agricultural Economics, commercial production in 23 leading states for the 10-year period 1937–1946, averaged 67,000,000 melons a year. A good but not an unusual yield per acre is 350 to 400 marketable watermelons or about 5 to 6 tons. Melons weighing about 32 to 34 pounds are rated as standard in size and are loaded 800 to 1000 per car. However, melons weighing no more than 18 pounds and loading 1,600 to a car are shipped. Yields of 4 to 5 tons per acre are considered average.

Fig. 66.—It is harvest time in this commercial watermelon field. (Mo. Agr. Exp. Sta.)

Watermelons may constitute a part of a regular crop rotation system. In some sections they are used as a catch crop or planted where a staple crop has failed due to floods, droughts and other causes. Melons are frequently planted on new land where the timber has been removed and the soil is being prepared for the culture of other crops.

Where Grown

Many different countries grow watermelons but the fruit is most popular in the United States. It is used mainly as a dessert. In the southern states particularly it is ranked as an important truck crop. Production in the commercial growing areas may change markedly from year to year. Some of the leading states in watermelon production listed without regard to ranking and in addition to those mentioned above are: Alabama, North Carolina, Indiana, Virginia, Arkansas, and others.

Climate and Soil

A sandy soil is everywhere considered the ideal for watermelon production. In many sections producers find that well drained, alluvial river bottom soils are satisfactory for good yields of quality melons. In fact, heavy watermelon yields are produced in the sandy river bottoms or delta soils of southeastern Missouri and in other districts having similar soil types.

Soil preparation should be to reasonable depths, and late fall, winter or early spring plowing is best. After plowing, the ground is frequently stirred at intervals to destroy weeds, conserve moisture and to keep the seedbed well prepared until planting time. Too much emphasis cannot be placed on good tillage before planting.

The watermelon is more sensitive to cold injury than other members of the Cucurbit family In fact, production is considered most satisfactory in long, warm growing seasons of the South. Here the days and nights are hot and frost rarely interferes with the plants from planting time until after the melons are harvested.

A long and relatively warm growing season is required for the watermelon. For this reason it is grown chiefly in the warmer sections although it may be grown in the northern districts by selecting early maturing varieties. However, a growing season of at least four months or more is needed. For home and local uses plants may be started in greenhouses or hot-beds a few weeks before time to plant in the field.

Manures and Fertilizers

The watermelon is a fairly heavy feeder and requires for good growth and production an abundance of plant food. An old and common practice is to place under each hill a shovelful or two of well rotted manure or compost and cover 2 to 3 inches deep with loose soil. A complete fertilizer like 5-10-5 or some other formula may be spread along the rows and mixed with the soil at the rate of 500 to 800 pounds to the acre. Ready available nitrogen fertilizers in addition may be used in moderate amounts after growth starts as side dressings.

Seeding and Spacing

The rows vary from 8 to 10 feet apart, with hills 6 to 8 feet apart in the row. In other sections a planting distance of 10 × 10 feet or even 12 × 12 feet may be popular and in use. Spacing distances are dependent upon the fertility of the soil, number of cultivations and type or kind of spraying or dusting outfit used.

Methods of seeding do not vary materially. After the seedbed has been thoroughly prepared, the land is marked in both directions at the desired planting distance. At each cross mark, hills are prepared and six or seven seeds are usually planted and covered to a depth of about an inch. Where the acreage is large drills adapted to such plantings are justified and are

frequently used. Also, if seed is plentiful, better results may be secured by machine plantings.

Thinning Melon Plants

To insure a good stand of plants more seed than required is planted, so melon fields usually need thinning of the plants in the hills. When the plants are well established and appear to be safe against the attacks of the striped cucumber beetle, the first plant thinning occurs when the plants may be reduced to about 4 or 5. In a week or ten days the remaining plants may be thinned to 2 or 3 of the strongest and best developed ones. Upon the growth of 3 to 4 true leaves for each plant the final thinning is performed and one plant only is left in each hill.

Cultivation and Irrigation

As soon as the plants in the rows of hills can be seen cultivation should begin. The main value of timely cultivations is to keep down weeds and break the surface soil crust and prepare the soil better for the absorption of moisture. The root systems of both watermelons and muskmelons are shallow, and light or surface cultivation is adopted to prevent root injury Also, it should be remembered in this connection that the roots in the surface soil may have as great or greater spread than the vines.

Watermelons may suffer injury from short periods of drought. For arid sections irrigation is considered an important cultural operation. In humid regions where rainfall is often deficient irrigation when needed may be well suited to good production for both quantity and quality.

Thinning the Fruits

Thinning the fruits often pays good returns because watermelons are graded according to size and shape. When the number of melons per vine has been reduced, the size of those left on the vine is increased. All damaged and misshapened fruits are also removed. When the growth of the largest melons is about 4 inches in length, all but 2 or 3 of the best ones are cut away with a sharp knife. For small sized varieties as many as 4 to 6 melons may be left on each vine. Home gardeners rarely thin the fruits but some wish to have a few large melons for show or exposition purposes and thinning practices are used.

Varieties

For shipping purposes, the markets demand a heavy melon, oval to long in shape, having firm red flesh and a tough rind able to withstand handling methods. Other needs are for melons of higher quality, containing fewer seeds, sweet flesh free from fibers and water cores.

Some of the leading varieties are Dixie Queen (White Seeded Cuban Queen), Wilt Resistant Hawkesbury, Florida Giant (also known as Black

Diamond) Blacklee, Leesburg, Wilt Resistant Missouri Queen, Klondike, Halbert Honey, Kleckley Sweet, Stone Mountain, Irish Gray and others. Early varieties for home uses are Fordhook Early, Cole's Early, Honey Cream and Peerless.

Harvesting

Watermelons require care in handling and they must be picked at the right stage of maturity. The important test is the sugar content of the flesh and ripeness of the seeds. However, judgment must be based upon certain external features and indications. The well known thumping test when the melon is ripe gives a rather muffled, dull or dead sound. When green the sound is metallic and ringing. This test should be supplemented by others. When ripe the color of the white spot where the fruit rests on the ground may develop a yellowish tinge or pale white color. Practice and experience counts in harvesting watermelons at the proper stage.

The watermelons should be cut and not pulled from the vines. As little handling as possible is suggested before shipping. Stacking in the field and leaving overnight should be avoided. In transporting the melons in trucks or other equipment cover the beds with generous layers of straw or some other packing material. To prevent stem-end rot in transit growers often apply bluestone-starch paste to the cut stems to prevent the development of stem-end rot.

Chapter 23

The Pumpkin, Squash and Miscellaneous Vegetables

THE pumpkin and squash have the distinction of being among the comparatively few vegetables believed to be natives of America. Long before this country was settled by immigrants from Europe, the American Indians used both the pumpkin and squash as food. These crops have many and varied uses, they are nutritious and valuable foods and are growing steadily in popularity. As fresh vegetables, they serve important purposes; a large tonnage of both pumpkins and squashes is canned and the product is used extensively for pie making. The home gardner may through proper handling and storing maintain a supply from midsummer to late spring.

THE PUMPKIN

(*Cucurbita Pepo* and *C. moschata*)

Pumpkins and squashes are placed in three species by horticulturists and botanists. The pumpkins belong to *Cucurbita Pepo* and *Cucurbita moschata*, while the true squashes belong to *Cucurbita maxima*. Nearly all the common varieties of pumpkins belong to *Cucurbita pepo*. Some pumpkins, however, due to certain definite characters are classified as *Cucurbita moschata*. They are very similar to the common pumpkin and for all practical purposes are pumpkins. Prominent varieties of the group are: Large Cheese, Canada and Golden Cushaw.

Pumpkins and squashes are closely related and their cultural requirements are similar. Both bush and trailing types are grown. Some confusion arises from the common use of the two terms pumpkin and squash. The fruit stem of the pumpkin is hard, woody, and furrowed or ridged lengthwise; while the fruit stem of the squash when ripe, is soft, spongy and devoid of distinct furrowing lengthwise. The summer squashes including such representatives as White Bush and Yellow Bush and the crooknecked type with such kinds as Giant Crookneck and Summer Crookneck. All of these are classified botanically with certain pumpkins.

Pumpkins usually make a rapid and extensive growth and they will thrive at somewhat lower temperatures than the cucumbers and melons. The demand for pumpkins is on the increase. Large quantities are canned in various sections of the country. It is widely grown in the central and southern areas as a companion crop with field corn. The pumpkin is generally preferred to the squash for pies for which it is famous. The crop

when grown extensively may also fill a real need for stock food. Yields per acre under good growing conditions may be unbelievably large.

Where Grown

The pumpkin has a somewhat larger or wider adaptability to the different sections of the country than the melon. Perhaps, farmers generally grow it more widely as a companion crop with corn than as a separate cultivated crop like muskmelons or cucumbers. However, where land is plentiful, pumpkins are usually considered, in the areas where grown, a dependable and worthwhile crop by home gardeners, truckers and commercial producers. Some of the leading states in production are California, New Jersey, Iowa and New York.

Climate and Soil

Pumpkins need for their good growth and development a fairly long, warm, but not unusually hot growing season. However, the summer types used widely by market gardeners and home producers, bear early and are used mainly in the immature stage, and can be grown where the season is comparatively short.

Rich, moist soils are preferred. Bottom lands and newly cleared areas may provide excellent opportunities for high yields and quality production. They are sometimes grown in the northern sections on heavier soils than are considered profitable for melons. Satisfactory soil drainage and adequate humus supplies are requirements as for other similar crops.

Manures and Fertilizers

On most soils where pumpkins are grown manure applied in the fall or early winter at the rate of 10 or more tons to the acre will increase production markedly. Cover crops and green manure crops plowed under and incorporated in the soil may give good results where manure is not available. Complete commercial fertilizers or nitrogen fertilizers alone are often used successfully in growing the green manure crops to increase yields for plowing under. The same fertilizers are also used as side dressings especially at planting time and somewhat later. A pH soil reaction of 6.0 should give satisfactory results. For some soils, phosphorus and potash may be particularly helpful in securing higher yields and better quality.

Seeding and Spacing

As is true for other vine crops, seeding in the field is delayed until the soil begins to warm up and the likelihood of frost injury is past. About 6 to 8 seeds of the vining types are planted in hills ranging from 8 × 8 to 12 × 12 feet apart. Even when ground space is limited rarely are the hills spaced closer than 6 × 6 feet. The bush types are planted in hills

about 4 × 4 or 4 × 5 feet apart and spaced in the rows from 3 to 4 or 5 feet apart. The depth of planting seeds is from 1 to $1\frac{1}{2}$ inches.

After the plants are well established and have produced 2 to 3 permanent leaves they are thinned to about 2 to 3 plants per hill. Such thinning generally gives higher yields but somewhat smaller pumpkins than thinning to one plant in a hill. Various spacing distances are used when the pumpkin is grown as a companion crop of field or sweet corn. The seed is usually planted after the last cultivation of the corn in the rows, one seed in each place, at distances ranging from 6 to 12 feet apart. Garden hoes or hand corn planters are used in the seed planting operations. No further attention is given the pumpkin planting. Also, if the corn is planted fairly late or after frost danger is over, the pumpkin seeds for the crop desired are sometimes spaced properly and planted with the corn and both crops are given the same type of cultivation.

Cultivation

Shallow cultivation is generally practiced often enough to keep down weed growth and loosen the surface soil. As soon as the operation is likely to do injury to the vines it is discontinued. A need may occasionally arise after cultivation ceases for pulling large weeds and the use of a hoe may be found helpful occasionally.

Varieties

In the winter or pie pumpkin group the following varieties are popular: Small Sugar, Connecticut Field, Winter Luxury, Turkish Honey, Ft. Berthold Golden Oblong, Omaha, Sandwich Island, Table Queen and Panama. Still other sorts of the moschata group are Calhoun, Japanese Pie, Kentucky Field, Virginia Mammoth, and Quaker Pie.

Harvesting and Storing

Winter varieties are allowed to become fully ripened before harvesting as keeping or storing qualities are increased. In cutting the stem from the vine an inch or two is left attached to the fruit.

Unlike most other vegetables, pumpkins store best at a fairly warm temperature, with medium dry conditions or a relative humidity of 70 to 75 per cent or less. Good air circulation is a requirement for satisfactory storage. With somewhat immature fruits and with those injured slightly, curing may be found profitable for about a month at a temperature of about 75° to 80° F. before placing in permanent storage. Pumpkins should not be piled or touch each other in storage.

SQUASH

(*Cucurbita maxima*)

The squash and pumpkin are so much alike they are frequently discussed together. Like the pumpkin the squash is considered a native of America

It is the vining type and matures fairly late. The stem or fruit stalk is large, soft spongy and comparatively free of grooves and ridges thus distinguishing the squash from the pumpkin.

Fig. 67.—Mulched plant of Yellow Straightneck summer squash. (Photo by Bureau of Plant Industry, Soils, and Agricultural Engineering, U.S.D.A.)

Where Grown

Leading areas in the production of squashes are found chiefly in the northeast and eastern sections and California. Such states as Massachusetts, New York, and Michigan are frequently mentioned in this connection. Its commercial culture is still confined in general to relatively small areas surrounding the larger cities and handled by market gardeners. Also, the annual commercial value of squashes may amount to several times as

much as that received for pumpkins. However, the pumpkin is believed to be grown more widely in home gardens.

Climate and Soil

Like the pumpkin, the squash is tender and susceptible to injury by cold and frost. However, it will endure somewhat lower temperatures than the melons. Also, heavier soils may be used than for melons. The squash is noted for its variable characteristics. It lends itself to a great diversity of soils and a wide range of climatic conditions. Clay loam soils are usually preferred for winter squashes. Being a rank feeder, the plant should be supplied with an abundance of soil fertility. A thoroughly prepared seed-bed is essential.

Manures and Fertilizers

One of the most practical and economical ways of meeting the early growing needs of this crop is to place under each hill at planting time at least two or three shovelfuls of well rotted manure. Later applications of both nitrogen and complete fertilizers may be applied if needed as side dressings.

Seeding and Spacing

The hills of large vining sorts should be from 7 to 8 feet apart in each direction. The rows may be laid out in checks and at the intersections the hills are prepared. After working up the surface soil into fairly wide and flat hills a half bushel of well rotted manure or compost is often placed in the bottom. It should be covered with 3 to 4 inches of good top soil.

The seeds are then planted from 1 to 1½ inches deep in this covering of soil. As many as 10 to 12 seeds are planted to insure a good stand of plants. When the plants are firmly established and beginning to vine, they should be thinned to about 3 to 4 to a hill. If the bush type of squash is planted, less space will be needed for their growth and production.

Cultivation and Irrigation

Cultivation is important in so far as it is needed to destroy weeds and keep the surface soil loose and mellow. It is likely to be needed after rains and following applications of water by irrigation methods. However, when the growth of the vines, begin to fill the rows and there is danger of vine injury, cultivation should be stopped.

Even under what may be considered ample rainfall, there are usually periods when dry weather may slow up or cause a stoppage of growth. Such checking or slowing down of growth usually reduces yields markedly. Growers should, therefore, endeavor to prevent growth slow downs and stoppages in every way possible. In most cases the use of a modern irrigation system adapted to the needs or requirements is the most practical and economical procedure to use in handling the problem. Yields should average from 10 to 20 tons per acre under fair to good culture.

Harvesting and Storage

Before frost occurs in the fall the squashes are cut from the vines. Curing in the field for a few days is generally considered a good procedure. Curing for about 10 days with artificial heat at temperatures of 85° to 90° F. with a relative humidity of about 80 per cent is used in some sections. In all the operations of harvesting and placing in storage, careful handling should be emphasized. Bruising, breaking the stem, and removing the small "button" at the blossom end of the fruit may cause rot infections to develop and rapid deterioration in storage.

Placing the fruits in single layers without touching is suggested. A temperature for storage of about 50° F. with a relative humidity of 50 to 70 per cent should give satisfactory results. High temperatures may result in considerable shrinkage of the squashes and a reduction in quality. Various types of storages are constructed. Some insulation of walls may be needed and heat in some sections is required.

Varieties

True squashes include such varieties as the Hubbard, Boston Marrow, and Delicious. The Boston Marrow is sometimes confused with the Vegetable Marrow which should be designated as a pumpkin. A few of the strains of the Hubbard squash are Golden Hubbard, Chicago Warted Hubbard, Blue Hubbard, Green Hubbard, and Kitchenette. The main differences in the Hubbard strains are in size, color, and time of maturity. All of the varieties mentioned have good keeping qualities. For quality the Delicious is often given first ranking. Such large squashes as Genuine Mammoth and Mammoth Whale produce coarse flesh and are considered poor in quality for table use. These varieties have a place for stock feed, exhibition purposes and for canning to some extent.

MISCELLANEOUS VEGETABLES

MARTYNIA

(*Proboscidea louisiana*)

This annual vegetable is a native of southwestern United States. The plants have a spreading type of growth and produce attractive purple colored blossoms. The fruits produced are of an unusual or peculiar shape and when young and tender are used to a limited extent for pickling.

Although seedings are sometimes made in the open in the southwestern sections, it is usually advisable to start the plants in hot-beds or greenhouses. Martynia is tender and easily injured by cold and frosts. The best growth and development is made in warm soils and sunny exposures. In the northern sections the plants are started under glass about the time that tomato plants are seeded. The plants are spaced in well prepared soil from 2 to 3 feet to 3 to 4 feet in rows from 3 × 4 to 4 × 4 feet apart. For best results culture similar to that suggested for tomatoes should be given.

OKRA

(*Hibiscus esculentus*)

This warm weather perennial vegetable is grown rather widely throughout the southern sections, and to a limited extent in northern districts. The young tender pods are considered excellent when boiled and served hot or cold as a salad. They are also used extensively in southern districts in soups and stews.

Seedings in the open are made on warm soils in the South. Fertile, sandy loams if available are preferred. The plants should be started in hot-beds or greenhouses in the North. The seed is sown in pots, paper bands and other equipment for transfer later to the field without disturbing the roots. Planting distances of about 12 to 24 inches in rows about 3 feet apart are commonly used. On depleted soils 10 to 20 tons of manure or 500 to 1000 pounds of a 5-10-5 fertilizer or a comparable formula generally increases yields markedly.

Varieties of both dwarf and tall types may be had. Some sorts also produce long pods and others short ones. A few of the leading varieties are Dwarf Prolific, White Velvet and Perkins Long Pod.

During the main harvest season the seed pods are usually harvested every other day. If the pods are not picked while tender they may soon become tough and woody and if not used promptly they deteriorate rapidly. Yields of about 250 to 300 bushels per acre may be secured.

MINT

(*Mentha*)

Such aromatic herbs as peppermint, Spearmint and Japanese Mint are grown to a limited extent in the gardens of America. Spearmint is popular as a flavoring herb and peppermint has a fairly wide use in medicines and the confectionery trade.

All may be propagated without difficulty from seeds, cuttings, or division of roots. In home gardens, throughout the country the seed is often sown in beds and the plants are allowed to grow and spread as conditions permit without further attention.

Better results are usually obtained by sowing the seed in drill rows 12 to 18 inches wide and covering it with about ½ inch of top soil. After the plants are established they should be thinned to about 3 to 4 inches in the row. A moist, fertile, sandy loam or a loam supplied with plenty of humus should give good results.

CHICORY

(*Cichorium Itybus*)

Chicory is a popular European vegetable. The thick roots are used mainly for salad. They may be cooked like carrots or roasted and used as a substitute for coffee. The leaves are also used as greens like those of spinach, chard and other vegetables.

A rather deep, rich loamy soil is needed for the growth of well-shaped, straight taproots about $\frac{1}{2}$ inch in diameter. The seed is sown about 110 to 130 days before the average date of killing frost in the fall. Rows about $1\frac{1}{2}$ to 2 feet apart are made in well prepared soil and the seed is sown lightly in the rows. The plants are thinned later to about 4 to 6 inches apart. When the seed is sown too early, tops bolting to seed or the development of multiple-headed roots may occur.

The roots are sometimes forced under greenhouse benches or in other structures suitable for the purpose. The roots are packed firmly in soil or fine peat and kept fairly moist. When the roots are harvested, the leaves are cut about 2 inches above the root tops.

GARDEN CRESS

(*Lepidium sativum*)

The chief use of the leaves is for salads. A rich moist soil is satisfactory for the growing of high quality cress.

Seed is planted early in the spring in rows about 8 to 12 inches apart. In about 6 or 7 weeks the growth is generally large enough to begin to pick for table use. The plants remaining soon occupy the spaces made by thinning. During the warmest days of summer, the plants may develop flowers readily. As soon, however, as somewhat cooler weather occurs, additional seedings may be made for crops in fall and early winter.

WATERCRESS

(*Roripa Nasturtium-aquaticum*)

This is a perennial plant which thrives best and naturally in slow-moving water of shallow spring branches or creeks. It may, however, be grown successfully in rather shady, moist corners or patches of the garden. For propagation, seeds or stem cuttings may be used. The plantings may be made in the moist and shady areas of the garden or in trenches along the edges of shallow streams from springs or creeks.

Once established, watercress persists and rather heroic methods may be required for extermination. About 7 weeks after plantings seeds, the leaves are usually large enough for the first picking. The ends of the branches or tips may be cut off about 4 to 6 inches in length.

CORN SALAD

(*Valerianella Locusta* vra. *olitoria*)

This plant is known also as lamb's lettuce and fetticus. The large rosette of leaves produced is used as a salad or potherb. As the flavor of corn salad is very mild, it may be used to an advantage with such vegetables as mustard and cress.

For good growth, a rich moist soil having an abundant supply of humus and nitrogen should be used. As a spring crop, the seed is sown in the open

as early in the spring as soil and weather conditions permit. Fall and winter crops may be started in August and September. Like some other vegetable crops, the rows may be protected against the winter cold by mulching, boarding and staking.

Rows are spaced about 12 to 18 inches apart and the plants are thinned to a stand of about 5 to 6 inches between plants. The foliage may be blanched by methods similar to those employed in blanching celery. When the plants are large enough for harvest, the whole plant is removed by cutting it off above ground. With good growth and development, the harvest stage should be reached in about 40 to 50 days.

FIG. 68.—Succulent, tender shoots and leaves of the wild polk plant used for salad greens and as a potherb. (Mo. Agr. Exp. Sta.)

THE COMMON POKEWEED

(*Phytolacca americana*)

This is generally a familar plant from Maine to Minnesota and southward. Poke has never been described as obnoxious but it is vigorous and sturdy of growth. When mature it may reach a height of 10 to 12 feet. Along roadsides in waste lands and elsewhere on fertile moist soils it may be found in abundance as a weed. The foliage and berries are ornamental in character and appearance. In fact, the common poke is sometimes planted in wild gardens and used as a tall plant in back borders.

From the earliest times to the present, the chief use of poke in the spring time has been for its young tender shoots alone or with other wild plants as potherbs or as poke salad greens. Some four or five years ago, a few enterprising produce dealers and handlers found a shortage of salad greens on the markets of Southwest Missouri and Northwestern Arkansas. There

being an abundant supply of wild poke available they naturally turned to this plant as a substitute for the cultivated greens such as spinach, chard, mustard, etc.

Both truck and express shipments of poke salad greens in limited and small quantities were made to local and distant markets. The response of handlers and consumers was encouraging from these beginnings. Shipments four years later are now being made in car load lots and by numerous trucks mainly to processing plants although there is some demand for the product in the fresh state.

Poke greens are harvested fairly near the establishments of the buyers and shippers. Local residents or families of the country and small towns and villages perform, under the directions of the buyers, practically all the picking or harvesting work. Each day the pickings are collected at a central point on the highways or railroads. Transportation by trucks and trains makes it possible to deliver the greens to the processing plant during the night or on the following morning.

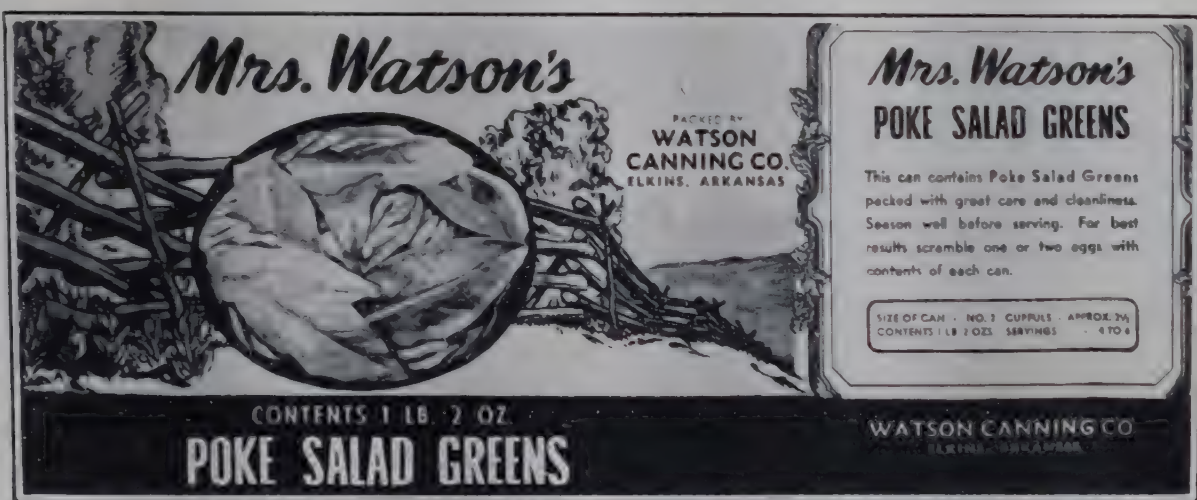

Fig. 69.—The processor's quart can label printed in attractive colors for poke salad greens. The product retails for 15¢ a can. (Mo. Agr. Exp. Sta.)

The picking season begins about the first of April and usually lasts about 2 to 3 weeks. For a good quality product the shoots should be cut when they are about 4 to 6 inches in height. Naturally, the best wild poke comes from the fertile waste lands in creek and river bottoms. Uncultivated fence rows, abandoned fields and weed and grass-grown ravines may furnish in seasons of plenty of rainfall abundant harvests.

Much interest has been aroused among producers regarding the matter of growing poke on a commercial scale as other greens crops are produced. The problem of producing the plants needed has been a drawback thus far. However, now that growers may be able to purchase poke plants from some forest conservation nurseries at moderate prices, it is possible that commercial production may soon be established. The matter of the selection of varieties or kinds best suited for bringing under modern cultural practices will have to come later.

The common name in use throughout the country is poke or pokeberry. Fairly recently poke has been propagated widely in state and national forest conservation nurseries. From such propagation areas it is being distributed to forest lands and wildlife areas to be grown as a food for wild life. It may be propagated or increased by seeds or by division of the thick roots. In as much as poke is believed to carry virus diseases, its extensive culture in commercial tomato growing areas may possibly increase tomato virus troubles.

Chapter 24

Vegetable Disease and Insect Control

A GENUINE interest and a good working knowledge of the control of diseases and insects harmful to vegetables is of paramount importance for successful production. An understanding of the life histories, habits and development of some of the most important diseases and insects cannot be overemphasized. With such information, the gardeners may be able to strike the pests when they are weakest and easiest to destroy. For example, such information may enable the grower to spray and dust at periods when the applications are most effective. Crop rotation systems can be planned wisely, and resistant instead of susceptible varieties may be planted. Also, it may be possible to plant early or late to avoid serious injury. The use of repellents to advantage may be considered. Finally growers may be able to shape and arrange their garden and farm practices along lines unfavorable to the growth and attacks of diseases or insects, one or both.

Vegetables, wherever grown, however, are subject to losses from the ravages of insects and diseases. Much of the damage incurred can be prevented as suggested above. It is always heartening and helpful to know that good disease and insect control practices usually go hand in hand with the best cultural methods. In the long run, therefore, due to the necessity of early adoption of approved disease and insect control practices, producers may actually be benefitted through heavy yields of high quality vegetables.

SOME SPRAYING AND DUSTING MATERIALS

Arsenates, (insecticides).—When used as sprays or dusts a poisonous residue is left on the plants. Insects that eat or feed upon leaves and stems may be poisoned and destroyed. However, the use of Rotenone and DDT have largely replaced arsenicals in vegetable insect control. Arsenicals are used according to directions on labels or containers. A 20 per cent dust may be prepared by thoroughly mixing 1 pound of lead arsenate with 4 pounds of hydrated lime.

Bordeaux (fungicide).—This is an old fungicide that has been used extensively on both fruits and vegetables for the control of fungous diseases. Perhaps it is still the most important fungicide for vegetables. It is frequently made according to the 3-4-50 formula, 3 lbs. bluestone (copper

sulphate), 4 lbs. hydrate of lime and 50 gal. of water. The mixture can be purchased as a dry product ready to use by adding water according to directions. Also, the chemicals for making Bordeaux can be purchased as bluestone crystals, copper sulphate granules, or powder. All forms have the same composition. Most growers use the so-called instant method of mixing. As the tank or sprayer is being filled, the powdered copper sulphate is sifted into the tank with the agitators running if possible. When the tank is about two-thirds full and all the copper sulphate or bluestone has been added, then sift in the lime as the rest of the water fills the container. Copper sulphate should always be added before the lime. Oil may be added after the lime if needed. Good agitation or mixing is required.

OLD AND COMPARATIVELY NEW PESTICIDES

Chlordane.—This is a new synthetic, organic insecticide. It destroys insects as a fumigant, a contact and stomach poison.

Cryolite and Fluosilicates.—These chemicals are stomach poisons for insects. Fluorine is the active ingredient. The materials leave a poisonous residue on the plants. These are old insecticides but they are still being used by growers in some districts.

DDT (*Dichloro-diphenyl-trichloroethane*).—This is another recently discovered product. It is a synthetic, organic insecticide and acts as both a stomach poison and a contact poison. It leaves a residue on the plants and may do injury to cucurbitous crops.

Methoxychlor.—This is the common name for another synthetic, organic insecticide. It is much like DDT but believed to be much less toxic to plants and warm-blooded animals. It is very effective against certain insects as indicated in the spray schedules.

Nicotine.—This is an old tobacco product used as a contact insecticide. It does not leave a lasting residue on plants. It may be used as both a spray and a dust.

Armite.—This new product is believed to be particularly effective against spiders, mites and ticks.

Dusting Sulphur.—Finely ground sulphur known as sulphur dust or sulphur flower is often used effectively against some of the milder fungous diseases such as mildew, leaf spot, etc.

Pyrethrum.—This is an insecticide like nicotine, as it is a contact material leaving no lasting residue on the plants. It is often used in home gardens.

Rotenone.—This product is derived mainly from cube, derris, and timbo roots. It is effective in controlling many insects attacking vegetables and it is relatively non-poisonous to man and other warm-blooded animals.

Toxaphene (*chlorinated camphene*).—This new chemical is especially effective against grasshoppers and cutworms.

Lindane.—This is another new insecticide, non-toxic to plants and particularly effective against aphids.

INSECT CONTROL FACTORS

ALERTNESS OR WATCHFULNESS. In the effective control of garden insects, this is the first important step. The interest and watchful eye of

the gardener in checking and scanning his vegetables and the soil about them may often enable the gardener to find small beginnings of insect attacks on a few plants only that may be exterminated easily. Also, if the attack is widespread, control measures may be started before material injury is done.

Hand-Picking.—This is an old-fashioned insect control method. However, for the home producer particularly it may still be effective for leaf-feeding caterpillars such as the hornworms, harlequin cabbage bugs, slugs, and others.

Clean Culture.—This method of combatting garden insects is frequently overlooked. Crop remains after harvest, trash, litter and the like should be collected and destroyed. Weeds, rubbish piles and neglected areas near gardens should also be removed and kept cleaned out.

Insecticides.—Chemicals or products that kill or destroy insects are called insecticides. This is important because in many instances, the proper use of chemicals as dusts or sprays constitutes the only check or control practice. The gardener often knows that these insecticides are divided roughly into three groups: stomach poisons, contact insecticides, and fumigants. With the introduction of so many new and effective insecticides this classification has lost some of its meaning as many of the organic materials may act both as stomach poisons and contact poisons and some may have in addition fumigant action.

PLANT DISEASES

Such plant diseases as the fungi, bacteria and viruses may reduce yields markedly in both commercial plantings and home gardens. The vegetables are attacked at various stages of growth causing damping-off, stem rots, leaf spots, wilts, root rots, poor growth, defoliation, unprofitable yields and even the complete destruction of the crops in some instances. It is not possible or practical to attempt to control all of these diseases through any one method such as spraying or dusting. However, inexpensive and practical remedies if properly used will prevent much of the loss caused by plant diseases.

KINDS OF DISEASES AND SOME CONTROLS

It is well known that vegetables and fruits may be damaged by several different kinds or types of maladies as stated above, some of them may be caused by fungi, others by bacteria, and virus diseases may be responsible for considerable injury. Also, disorders of various types may be caused by unfavorable weather conditions, soil deficiencies and the like.

Fungous Diseases.—The fungi damaging horticultural crops are generally made up of a group of plants microscopic in size, which do not possess the green coloring matter common to flowering plants. Those attacking vegetables and fruit crops procure their food mainly from living plants. They are therefore, frequently called parasites.

The fungous plant is made up of a large number of very small thread-like structures which may grow in and upon the fruit or vegetable plant. These thread-like bodies are known as hyphæ and when considered together, include a mold-like mass known as mycelium. Individual hyphæ grow in the plant tissues and extract nourishment from them. The plant or its parts attacked by the fungus may be greatly weakened or killed. The fungus, like the higher plants may form reproductive bodies known as spores. These spores are microscopic in size and are comparable to the seeds of fruits and vegetables.

The spores or "seeds" are blown about by the wind and when they come to rest on their food plants, may germinate under favorable temperature and moisture conditions. In so doing, a germ tube much like the first small roots of seeds is produced. This tube enters the host or food plant, often through the stomata of leaves or through wounds on the surface of plant tissues. Having entered the plant, the germ tube begins to branch and soon develops a mass of threads or mycelium within the plant.

Once the fungus is established, dilute spray chemicals or dusting materials cannot enter the plant tissues in sufficient quantities to kill the fungus without also killing the surrounding host cells. It is important therefore, that the germinating spores be destroyed by spraying or dusting properly before their germ tubes enter the tissues of the plant. The purpose of sprays and dusts is to completely cover the leaves, stems, and fruits, and thus prevent spore germination and entrance of the germ tube into the plant tissues. The objective of the grower should be to keep the susceptible parts of the plant thoroughly covered with a fungicide or protective spray or dust in order to destroy the germinating spores before they enter the tissues of the plant. The sprays and dusts that prevent injury and kill the spores of fungous diseases are called fungicides.

The loss from the attacks of fungous diseases are prevented by timely applications of fungicidal sprays and dusts when spore spread and germination may occur. Some of the familiar and common kinds of fungicides used as sprays and dusts are bordeaux, dry lime-sulphur, lime-sulphur solution, and many other forms of sulphur and copper and new fungicidal products, distributed, and sold under various trade names.

Bacterial Diseases.—Such diseases as fire blight of apples and pears, bacterial wilt of vegetables and others are caused by a group of very minute plant organisms called bacteria (singular, bacterium). These microscopic plants differ from fungi, chiefly in their method of reproduction. In general, instead of producing spores like the fungi, multiplication occurs by division or dividing of the rod-shaped organisms in the middle. By the process of division, bacteria may multiply very rapidly. Millions may be produced from a single organism in a few days.

Dissemination or spread is accomplished mainly by insects, wind, and rain. It is not necessary therefore, for bacteria to produce spores as fungi do. However, some bacteria form internal spores to carry the organism over unfavorable seasons such as drought periods and winter. When these spores enter the plant, food is absorbed from the host tissues. In a comparatively short time division takes place and many thousands of new bacteria may be developed in the plant. Spraying and dusting is impractical

because the bacteria are inclosed in the tissues and cells of the plants and cannot be reached as in the case of fungous spores on plant surfaces.

Preventive methods are emphasized, therefore, in all control practices. The producer should start with clean, healthy, and non-infected plants. The growing of resistant varieties and strains may be a very worthwhile procedure. Also, infected plant parts should be eliminated. Since the bacteria may thrive and reproduce much more rapidly upon luxuriant or rapid growing plants, growth inhibiting practices may be needed in combatting the infections. Such slowing up or inhibiting methods consist of stopping cultivations, withholding fertilizers, and discontinuing heavy pruning.

Virus Diseases.—Virus diseases create an infectious condition, apparently without the presence of any visible causal organism. Transmission is brought about by an agent or principle so small that it can pass through ordinary bacteria-proof filters. Mosaics of tomato and potato and yellows of the asters and the peach are typical examples in the group. Plants infected by mosaic disease may show mottling and discoloration of the foliage, while those infected by yellows often develop lack of color in the flowers and dwarfed leaves which possess little or no chlorophyll and turn yellow. Other symptoms such as malformation and a stunted type of growth may appear.

Virus diseases are common and serious among herbaceous crops and the bramble fruits particularly. The disease is less often encountered in tree fruits. Furthermore, the exact causes are unknown, but the disorders are spread through a plantation by insects. Wind and rain under some conditions may be responsible for dissemination. Grafting and budding, the intermingling of roots and the juice of diseased plants may produce infection.

Control and prevention consists chiefly of digging, cutting out and burning affected plants, and destroying and repelling virus-carrying insects. In starting new vegetable and fruit plantings, care should be taken to select disease-free stock and to plant on soils free from infection and infected plant refuse. The growing of resistant varieties and strains is also recommended.

ROTATION OF CROPS

Planned rotation of crops may be effective in disease and insect control when the crops subject to attack are grown on the same land not oftener than once in 3 or 4 years. Rotation of crops is often especially valuable in preventing losses by diseases that are continued by propagating parts or spores (seeds) which live only 1 or 2 years. This suggestion applies particularly to some diseases of the cabbage family such as club root. On the other hand, the potato scab disease and onion smut cannot be controlled by the usual crop rotation systems, because the organisms responsible for the diseases may live in the soil for several years.

The gardener should know as much as possible about the kinds of crops affected by the different diseases. Some diseases affect only those crops closely related, others attack only one crop, while still others damage many

kinds of vegetables as they are not limited to the same species, genus or family. A specific example of one pest attacking many different crops is a species of nematode (*Heterodera radicola*) which causes root knot. The remedy is a rotation of crops in which immune or resistant crops are grown for 2 or 3 years.

USE OF RESISTANT VARIETIES

The plant breeding programs and projects of the State Agricultural Experiment Stations and the United States Department of Agriculture have made noteworthy progress in developing varieties of vegetable crops with resistance to some of the serious diseases. Also, it is well known that in many instances the use of the known resistant sorts is the only practicable means of preventing serious losses. This may be particularly true in fields and gardens in which the diseases have become established in the soils. Nearly all planting areas become infested in a few years. A common example of the value of resistant varieties, is in combatting the spread of the tomato wilt fungi. Although considerable portions of the susceptible crops may become infested the fungi do not develop rapidly in the resistant varieties and fair to good yields may be produced in spite of the infection.

SANITATION

The fall and winter refuse of the previous spring and summer may carry over the winter the parasites that cause plant diseases. Diseased plants that may appear during the growing and harvesting periods should be removed from the fields and gardens and burned. Regular and systematic clean-ups in the fall should be made a part of all good cultural practices. All refuse should be raked, piled and burned before fall and winter plowing. The practice of collecting diseased and decaying vegetables in piles scattered over the area may be particularly advantageous in the spread of dangerous diseases. In collecting this waste, it is much safer to burn or bury deeply such refuse.

SEED TREATMENT

Seed treatment is economical and may be performed without difficulty. Nearly all seed stores handle the chemicals and full and explicit directions for use are given on or within the packages. The seeds are not injured by the treatment and it may be applied at any convenient time unless otherwise specified in directions for use. Rarely, if ever will it be possible to find a single seed treatment that may be used effectively and without harm on all garden seeds. Diseases or parasites found on seeds vary with the different districts or areas in which the seed was produced.

Two important objectives may be accomplished through seed treatment. First, the organisms on or adhering to the seeds which cause the disease may be killed; second, the seed treatment may protect the seed and young seedlings from injury or destruction by decay organisms likely to be present in the soil. Seed treatment may be particularly valuable to gardeners

during cold, wet weather following planting, because the treated seed may give good to fair stands of plants while untreated seed may often produce thin or poor stands.

Fig. 70.—Black rot on sweet potato sprouts in the hot-bed. Note that some sprouts were killed. Sprouts having rootlets above affected areas may survive, but should not be planted. This disease can be prevented. (Kansas Agr. Exp. Sta.)

Some of the chemicals used successfully by growers are: New Improved Semesan, Jr.; New Improved Semesan; Spergon; Semesan Bel; and Arasan. Whatever chemical product is used in seed treatment, it is essential for good results that great care and pains be taken to follow all the directions and suggestions as completely and carefully as possible. It is obvious and evident that unless the treatment is given a fair chance it may not work.

GOOD CULTURAL PRACTICES

Soil Fertility and Cultivation.—Gardens and fields of vegetables on land of good fertility, well prepared for planting and properly cultivated may grow paying crops. Similar soils just across the road poorly handled with little preparation for planting and irregular cultivation may suffer seriously from both disease and insect attack and make profitable returns impossible. All are aware of the fact that vegetables that are vigorous and sturdy and on ground free from weeds may show great resistance to plant parasites. Furthermore, soil fungi may attack the roots of plants but strong healthy vegetables may have the ability to grow new roots faster than the older ones are destroyed and thus produce paying crops.

Fig. 71.—Convenient arrangement for treating seed potatoes for surface-borne diseases. (Mo. Agr. Exp. Sta.)

Watering Vegetables.—In the greenhouse, hot-beds and cold frames containing vegetables that are to be transplanted to the garden or field at a later date watering may become an important problem. This is true because the fungous disease known as damping-off is encouraged by high humidity, cloudy weather and crowded beds of seedling plants. Better aeration by opening ventilators and raising sashes or covers, wherever possible is usually helpful in preventing high or excessive air humidity. It is clear, therefore, that frequent watering and closed structures encourages or makes conditions favorable for the growth of the damping-off fungi.

The plants should be watered at regular intervals with the amount given depending upon the dryness of the soil and the need of the plants.

More frequent watering with little or no regard for the needs of the plants may cause damping-off and other troubles. Where and when possible, watering in the morning and aerating the beds by leaving them open during the day may prove to be a good practice. More water than required for good growth and development is likely to prove harmful.

Leaf and Fruit Diseases.—Leaf and fruit diseases in fields and gardens may be spread by cultivating during the morning hours while the dew is on the plants. This may be especially true for some bacterial diseases like leaf spot blight which are usually more difficult to control than fungous diseases. Disease organisms may be easily carried through the rows of vegetables from diseased plants to healthy ones. The drops of water formed from the dew and rubbed off by the garden tools and clothing of the workers make the spread of diseases possible.

SPRAYING AND DUSTING EQUIPMENT

Spraying on an extensive scale may be done with a power sprayer, barrel and pump sprayer, or a traction sprayer. Effective work may also be done in a smaller way with the knapsack sprayer, the bucket pump sprayer, the hand atomizer, and other equipment adapted to the distribution of a liquid spray or a dust.

Dusting outfits may also be used with good results. The equipment is arranged for blowing and distributing the dust over infected plants. Power and traction dusters are in use by commercial growers but most home gardeners use the hand outfits. Effective dusting may be made over a small area by using a talcum powder can, a tin can in the bottom of which a few holes have been made, or a porous cloth bag may be employed.

The dusting equipment should be adapted to the size of the garden or truck crop to be covered. Where the apple orchard is being dusted with a power outfit or some other type of machinery the same equipment can often be used in the garden or field.

SUMMARY OF GARDEN INSECT CONTROL CHART

1. All measurements are level.

2. Home gardeners should keep an inexpensive duster and sprayer in the cabinet with insecticides.

3. In spraying or dusting avoid positions that permit the wind to blow the fumes, dust or spray on face, hands and clothing.

4. Wash thoroughly after using insecticides.

5. Control can be expected if the insecticides and equipment are ready for use *at the right time* but thorough work must be done.

6. The insecticides should be used at the dilutions given and as near the periods suggested as possible.

GARDEN INSECT PEST CONTROL CHART, FEBRUARY 1952
Courtesy V. F. Burk and Lee Jenkins, Department of Entomology, University of Missouri

		Dosages			
		Sprays			
Insects	*Insecticides Use only one unless indicated otherwise*	*Lbs. in 100 gals.*	*Level teaspoons in one gallon*	*Dusts*	*Remarks*
Mexican Bean Beetle	Methoxychlor	2 lbs. 50% W.	2		Rotenone only safe ma-
Bean Leaf Beetle	Dilan			1½ to 2%	terial to use near harvest.
	Rotenone			75%	Cover both sides of leaves
	Cyrolite	6 lbs.	6	25%	
Flea Beetles	Methoxychlor	2 lbs. 50% W.	2	3 to 5%	Apply as beetles appear.
	DDT	2 lbs. 50% W.	2	3 to 5%	Eggplant, etc.
	Lindane	1 lb. 25% W.	1	1½%	
Plant Lice	Lindane	1 lb. 25%	1	1½%	On both sides of leaves
	40% Nicotine Sulphate	1½ lbs. or 1 Pt.	2		
Cabbage Worms	Methoxychlor	2 lbs. 50% W.	2	3 to 5%	Apply as injury starts. Stop 3 wks. before harvest
Blister Beetles	Toxaphene			10%	
	Methoxychlor	2 lbs. 50% W.	2	3 to 5%	Spray or dust thoroughly
Tarnish Plant Bug	DDT	2 lbs. 50% W.	2	5%	Repeat as needed
Harlequin Cabbage	Toxaphene	3 lbs. 40% W.	4	10%	Most effective when bugs
Bug	DDT	2 lbs. 50% W.	2	10%	are young
Grasshoppers	Chlordane	1½ lbs. 50% W.	2	5%	Apply when hoppers are
	Toxaphene	3 lbs. 40% W.	4	10%	small on garden borders
Colorado Potato	DDT	2 lbs. 50% W.	2	3 to 5	Apply when beetles appear
Beetle	Methoxychlor	2 lbs. 50% W.	2	3 to 5	
Vining Crop Pests	Methoxychlor	2 lbs. 50% W.	2	5%	
Melons, Cucumbers,	Plus				Add Lindane for plant lice
Squash & Pumpkin	Lindane	1 lb. 25% W.	1	1½	and squash bug only. Stop
Corn Ear Worms on	DDT 25%	4 gal.	10 tablespoons		on cukes 2 wks. of harvest
Corn	emulsion plus	10 gal.	25 tablespoons		Apply as 25% silks emerge
	refined mineral oil				Repeat in 4 to 5 days
	(50–90 SAE & Water)	86 gal.	1 gal. water		
Cutworms	Toxaphene			10% dust	
	Lindane, 25% W.	Use 1 teaspoon in 1 gal. of water as plants are set			

A BRIEF DISEASE-CONTROL PROGRAM FOR SOME GARDEN VEGETABLES

Vegetable	*Disease*	*Treatment*
Beans	Powdery mildew	Dust with sulfur, 1 to 7 parts of lime.
	Rust	Sulfur dusting or spraying fairly effective. Disease-resistant varieties usually best remedy. Weak bordeaux spray suggested 2 tablespoonfuls to 1 gal. of water.
Carrots	Late blight (carrots planted in summer may become infected)	Spray thoroughly about 4 weeks after seeding, then follow with applications once a week if needed. Bordeaux may be used as above.
Cucurbits: cantaloupe cucumber honey dew muskmelon pumpkin squash watermelon	Leaf blight, Rust, Anthracnose (leaves show black spots which enlarge and finally kill leaf blade)	Spray thoroughly with bordeaux mixture as soon as any leaf spotting is found, same dilution.
	Powdery mildew	For cucumbers and honey dew melons dust lightly with sulfur. On other cucurbits do not use sulfur, as it may injure the plants
Onion	Downy mildew (spots of violet-colored fuzz appear on leaves and stalks. The tissues loose color and die)	Spray at first appearance with lime-sulfur. Repeat application as often as needed. Use 3 tablespoonfuls to 1 gal. of water.
Pea	Downy mildew	Preventive spray best. Use bordeaux before mildew develops. No treatment effective after mildew attack
	Powdery mildew	Dust with sulfur before the disease appears, or use lime-sulfur spray

Chapter 25

Marketing and Storage of Vegetables and Fruits

MARKETING

THE problems of the commercial grower do not end with the production of an abundant and high quality product. In fact, for many producers picking, grading, packing, transportation and selling practices or procedures may become the most difficult of all. Look well, therefore, to the problems ahead and prepare for the harvest season because it can bring more grief and worry than all the other operations combined.

Some of the elements of risk such as weather are beyond the control of the producer but the adoption of the best known growing, marketing and storage practices may help to meet these more successfully. There are, however, important factors that can be affected by efficient management, superior knowledge and diligent study and investigation. Careless and indifferent management coupled with unsound judgment and wasteful practices may increase the costs of harvesting, handling and storage and thus eliminate all opportunities for profit.

SOME MARKETING ESSENTIALS

A few of the fundamentals or principles influencing the marketing of vegetables and fruits follows: (1) a high quality and seasonable product; (2) consistent and uniformly graded products; (3) packing adapted to the crop and acceptable to the buyers; (4) clean and attractive vegetables and fruits and containers of suitable sizes and shapes to meet the needs of the market; (5) scrupulously honest in grading and packing and open and fair dealings with buyers; (6) exercise of judgment and discretion in accepting buyers and the securing of reliable and competent assistance when needed; and (7) careful study and practice of good salesmanship.

In general, growers are more successful in producing crops than they are in selling them. Perhaps, it is well that this is true, because rarely will one become highly proficient in both production and marketing. Even though his main or principal job is the growing of good marketable products he should have a satisfactory working knowledge of market demands and modern methods of handling both perishable and non-perishable produce.

Vast improvements may be made by nearly all growers by taking a keen and dynamic interest in all of the producing and handling problems. All

will agree that there are great opportunities for improving yields and quality through the use of better varieties and strains, and the adoption of superior harvesting, grading, packing and other handling procedures. These are practices for which the grower is responsible and in most instances he is able to alter or change them materially.

In all of the operations from harvesting to storage and finally to selling on the markets, it is of paramount importance that the grower keep in mind the fact that vegetables and fruits even after harvest are living organisms. They actually respire as water is lost through transpiration or leakage from pores or tissues. Fairly rapid chemical changes within the products may occur. These and other processes cause a gradual but sure deterioration or breaking down of the plant or fruit tissues. The object or purpose of all handling and storage methods, therefore, is to retard or slow up the life processes of the fruits and vegetables without entirely stopping them.

HARVESTING

Few if any definite rules can be established regarding the exact time to pick or harvest. The stage of development, weather conditions at the particular period, distance to market, type of transportation, and time needed to reach the consumer are some of the problems confronting the grower. Also, crops such as sweet corn, lima beans, snap beans, and peas lose rapidly in taste and flavor after edible maturity is reached. Naturally, for satisfied consumers and higher prices these crops should be harvested and marketed as nearly at the proper ripening stage as possible. With these and other products which increase in size after the edible stage is reached, there is frequently a tendency for producers to delay the harvest. This is usually a serious mistake as it rarely pays in the long run to give up quality for quantity. Tomatoes and muskmelons are outstanding examples of vegetables which are often harvested and shipped to the distant markets long before the ripened condition or edible maturity is reached. Under such handling, the reaction is to depress the market, lower prices and discourage buyers and consumers.

There are no requirements more important in the marketing and storage of vegetables and fruits than alertness and promptness in harvesting and handling methods. One day's postponement may result in great losses, particularly in hot, sultry and dry weather. Frost occurrence is another hazard requiring prompt action in most instances. Much of the tremendous losses that occur through carelessness in harvesting and handling vegetables could be prevented by emphasizing proper instructions to helpers and by giving timely supervision as needed.

PREPARING VEGETABLES FOR MARKET

The purpose of consumer packaging is to make the vegetables suitable for cooking, or serving raw without further attention. The importance of cleanliness, elimination of decayed, diseased and discolored leaves, stalks, and roots in the trimming preparations can hardly be overemphasized.

Much more care and preparation is required than when vegetables are handled in bulk. Spinach, lettuce, asparagus, celery, root crops and other vegetables are usually washed to remove soil particles and improve the general appearance of the product. For convenience in handling and to prepare a product having a neat and attractive appearance, vegetables such as radishes, beets, carrots, celery, broccoli, green onions, asparagus, and others lend themselves to tieing in bunches. In trimming, washing, tieing and other handling methods preparatory for the markets, emphasis should be placed upon the creation of a wholesome, neat and attractive product.

Fig. 72.—For vegetables of such high quality and good appearance there is generally a strong demand. (Mo. Agr. Exp. Sta.)

GRADING VEGETABLES AND FRUITS

When vegetables and fruits are divided or graded into uniform lots, selling prices may be based on grade. By so doing, the marketing or disposal of the product is made easier. All the products in a certain grade must be alike or uniform for grading to be a success. This is true because poorly graded or ungraded crops of high quality may frequently sell for less than well-graded ones of lower quality. It is often true that a few inferior specimens in a package may set or influence materially the price paid for the entire lot.

Although size for the grade is important, other factors must be considered. Uniformity includes not only size but shape, color, degree of ripeness, freedom from blemishes and insect and disease injuries. All of the specimens should be as nearly alike as to absence or occurrence of these factors as it is possible and practical to make them in complying with the grading rules. At all times the objective, good appearance and high quality, should be kept in mind. The adoption of standard products is recognized as fundamental to successful marketing.

PACKAGES AND PACKING

It is obvious that there are many reasons for the use of packages in handling vegetables and fruits from the field or planting to the markets. Some of these are to facilitate the handling operations, to provide a unit or measure for the product, to protect it from injury, and to promote cleanliness. Still others are to provide ventiliation, to make possible a method for establishing a trade mark and to do worthy advertising, to meet legal requirements and to promote other important procedures in marketing.

There are many containers of various sizes, shapes, colors, and made of different materials. Much confusion and uncertainty exists among producers and handlers. Naturally there is great need for standardization of containers and the elimination of many kinds and sizes and the lowering of costs. However, there appears to be a significant trend at present toward the adoption of smaller containers suitable to many different crops. Already the "pony" cantaloupe and celery crates are being used. In some districts, the 100-pound potato sacks are replacing the 150- and 180-pound sacks. A rather extensive use of cloth bags containing from 5 to 10 pounds, mesh bags for onions and other vegetables and fruits of similar sizes, and numerous types of cartons are employed for the packaging of tomatoes, celery, rhubarb, asparagus and other products.

PACKING FOR THE MARKETS

The guiding principle or object should be an honest pack. The grower is always hurt worse than anyone else if he permits or tolerates dishonest packing. The grower should have in mind the protection of the product in handling and transportation and also consider carefully the demands of the market. In so doing he will endeavor to meet both requirements—protection of the product from injury and the presentation of a neat and attractive package. Other important essentials include a uniform pack from the top to the bottom of the container. The most satisfactory results are also likely if the specimens making up the product are so arranged and placed as to permit arrival on the markets in good condition and present a pleasing and orderly appearance.

CONSUMER PACKAGING

Since self-service has now become general in a large percentage of the retail stores throughout the country, the so-called consumer packaging has demonstrated its value in the needs of this fairly new development. In some instances mesh bags, paper bags, trays and bags with transparent film fixtures for display purposes have been put to worthwhile uses in marketing. Perhaps most of the experience with consumer packaging has occurred near the consuming centers by large sellers or handlers such as the chain stores.

Thus far the practice of prepackaging has been performed by both the producer and seller. It is believed by some that the operation should be

carried on throughout the year to make it most economical. If this is true, perhaps large handlers and sellers are better equipped to perform the service than the grower. Improvement, however, in refrigeration, packaging and transportation may have much to do with making the producing center the ideal place for consumer packaging.

TRANSPORTATION

The expense of transportation and the problems involved are usually much greater for the truck grower located at some distance from the market than for the market gardener near the population centers or cities. The short hauls near the markets are in nearly all instances made by trucks. But truck growers may use a variety of transportation means such as train, boat, truck and even the airplane in special instances. Long distance shipment generally requires in warm weather refrigeration and in cold weather heating, which increase the cost of marketing. The market gardener does not have these expenses but he may produce his crops on much higher priced land than the truck grower. Property values generally may be comparatively high which usually means increases in tax burdens.

It is interesting to note that, according to the best information available, considerably more than 50 per cent of the truck hauls are limited to about 50 miles. Although it is well known that motor truck transportation of vegetables and fruits ranging from 300 to 600 or even 1000 miles is not uncommon. A radius ranging from 100 to 150 miles from the truck farm represents on the average the distance of most of the hauling.

PRECOOLING OF VEGETABLES AND FRUITS

To retard ripening and deterioration after harvesting, vegetables and fruits are often precooled without delay in order to remove the heat accumulated under field conditions. Various methods of removing the heat are employed especially for the different distances of shipments. Precooling is done just before or soon after loading. Temperatures may be lowered by passing the vegetables through a spray of ice-cold water or by dipping the products in the cold water. Such crops as spinach, celery, peas and the root crops are adapted to these treatments. Perhaps on a large scale, precooling quickly is most often accomplished by placing the products in properly equipped refrigerator cars where the air circulates freely around the stored ice.

Unless the products are shipped under refrigeration, precooling is generally of little value except possibly for short hauls. Cooling may be fairly rapid where ice is placed in the package of carrots, bunched beets, lettuce and still other root crops. On the top layers of vegetables snow ice when blown over the lot in refrigeration cars facilitates the lowering of temperatures where the warmer air tends to collect. The moisture received in such treatments may also be beneficial.

SELLING ON THE MARKETS

Growers dispose of their products or sell them by means of various methods on both retail and wholesale markets. For example, retailers are supplied by trucking or shipping to city retailers; by making sales to wholesale markets; by selling at the farm or at the roadside markets. Sales are also made to country buyers and shippers; to trucking handlers at both city and regional markets; to jobbers in the markets and through producers cooperative organizations.

One of the most difficult problems in commercial vegetable and fruit handling is good distribution. Slumps and low prices on the markets are most often due to uneven distribution. In one city the supply of a certain product may be low and inadequate for service while in another an abunant supply may be available and prices considerably depressed as a result. All should be interested and willing to do everything possible to prevent crowding the markets. Individual producers, however, are practically helpless in most instances. It is generally believed that organizations functioning on behalf of all concerned are best fitted to cope with distribution questions and to do something about them.

ROADSIDE MARKETING

With the rapid development and expansion of the highway systems throughout the United States in fairly recent times, roadside marketing in the districts of cities and towns has received a tremendous impetus. These changes and developments came chiefly as a result of the growth and extension of travel by automobile. Roadside markets vary in size and importance from the collection of a few vegetables and fruits under the shade of a tree near the highway to substantial and attractive structures covering considerable areas and splendidly equipped for serving the public with high class products. Some sell only the vegetables raised by the producer, others sell their own products and buy for resale, and still others buy all they sell from the growers and markets.

Some of the requirements usually listed for operating a roadside market successfully are:

1. Location on a heavily traveled road and within about an hour's drive from the city.
2. Stands that exhibit to advantage attractive display signs.
3. Easy and safe driveways with adequate parking space.
4. Good quality products and a continuous supply.
5. Fair prices, good measure and extra efforts made to please customers.
6. Cleanliness everywhere, attractive fruits and vegetables in neat and suitable containers.
7. The stand should be prominently exposed and well marked.
8. As most drivers buy on the return trip, a location on the right side of the highway leading to the town or city is considered best.
9. Fruits and berries may help sell vegetables. Among the vegetables cantaloupes and tomatoes may be particularly popular.

10. The operation of the roadside market throughout the year may not be feasible or practical due to inability to obtain supplies or for other reasons. For success it is important that the period of operation be as thriving and lively as conditions permit. The business should never be allowed to gradually die as marketing methods at a later time may be made more difficult.

HARVESTING AND STORAGE FOR HOME USES

Vegetables generally are harvested at their best eating stage when they are young and tender. At this period of growth they contain more food value and usually possess a superior flavor. Some like turnips, potatoes and sweet potatoes are harvested for storage when fully mature. Others like tomatoes and cabbage may be slightly immature when harvested for storage. Cabbage, rutabaga, turnips, etc., will withstand considerable cold, frosty weather, while potatoes, melons, beans, etc., must be harvested before frost.

In general vegetables and fruits are not improved by storage. It is usually best to select products that are still growing, as this growth process continues in storage, but at a slow rate. Fresh, clean vegetables free from bruises and defects, produced from late summer and early fall plantings are likely to give best results in storage.

Perhaps only those who have grown and stored vegetables in their fresh and unchanged condition can appreciate the possibilities and value of such a food supply. The savings in the family budget that are possible may be important for both town and country home gardeners. Some gardeners may prefer to can their vegetables instead of trying to keep them in pits, cellars or other storage structures during the winter. Nearly all will admit that there are sound reasons for the canning procedure. Some strike a compromise by canning the produce difficult to store and placing the rest in suitable cold storage.

Vegetables have widely different storage requirements. For the proper preservation of the products, these different conditions must be as completely satisfied as possible. Naturally, the striking variations in requirements makes it impossible for one type of storage to be used successfully for all vegetables.

Again, it must be emphasized that all vegetables are still alive and carrying on life processes, even after removal from the soil. Storage, therefore, is for the purpose of slowing down life processes, but providing for their continuation at a markedly reduced rate. Just how well the gardener is able to handle and adapt the storage needs of the different kinds of vegetables to the facilities available constitutes an economical and intriguing problem for him.

Types of Home Storage.—Dark, cool basements and cool root cellars supplied with good aeration or ventilation may be well suited to root crops like beets, carrots, parsnips, potatoes, rutabagas, salsify, and turnips. When stored in moist sand, sawdust or soil the storage life may be lengthened and the products improved.

STORING IN PITS.—Storing in pits will vary some according to the climate of the section. For instance, since the danger of freezing in the southern states is not as great as in the North, less protection is needed. Choose a well drained spot and make a shallow excavation, 3 or 4 feet wide and 6 inches deep. Put a good layer of straw in this trench and over the sides and pile the vegetables in a conical heap. The length will depend on the amount to store. Cover the vegetables with 1 or 2 feet of straw, depending upon the amount of protection necessary. As the weather gets colder put 4 or more inches of soil over the straw. In very cold sections more protection may be needed; strawy manure can be used over the whole mound.

Good ventilation should be provided when vegetables and fruits are pitted. Ventilation can be secured through leaving a slight space at the top where the straw is exposed, or by inserting a ventilating flue that will stick up through the top. A drain tile stood on end above the pile may serve for this purpose and a piece of screen placed at the bottom will keep out rodents. Ventilators should have a cap to keep out rain. In the coldest weather some plugging of the flue with straw or hay may be needed to guard against cold injury.

Cabbage can be kept better by outdoor storing. Dig a trench 6 inches deep, wide enough to hold three heads, and as long as needed to hold the number of heads to be stored. If the soil is not well drained, the cabbage should be placed on the surface instead of digging the trench.

Pull the plants, roots and all, and stand them heads down, three wide in a trench. No leaves should be removed. Then on top of the three rows and between their stems place two more rows, roots up and intact. Next, put a layer of straw over all and cover with soil. The thickness of the cover will depend on the weather conditions but, since freezing does not injure cabbage as it does other crops, it is not necessary to cover enough to completely prevent freezing.

Celery can be stored in a dark cellar by digging up the plants with the roots and setting them close together in soil on the cellar bottom or in boxes. The soil around the roots should be kept moist but the tops must not be wet or disease is likely to be serious. Plants handled in this way in a cool, dark cellar should provide well blanched celery for the winter season. If it is possible to keep the temperature just above freezing and provide good ventilation, this is an ideal way to store celery.

Large quantities can be stored in a trench dug in well-drained soil. Have the trench 12 to 15 inches wide, as deep as the plants are tall and as long as desired. Dig the plants with roots on and set them close together in the trench, water the soil about the roots but be careful to keep the tops dry. Cover the tops for shade. As the weather gets cold put on straw manure to prevent freezing.

A few vegetables need warm, dry storage conditions, like the floor of a furnace room or warm basement of the home. The attic often makes a good storage place for pumpkins, squashes and sweet potatoes. (See discussions of individual vegetables for additional suggestions on storage.)

COMMERCIAL STORAGE

Great progress has been made in the storage of all food products in recent decades. The changes and advancements made have varied and improved the consumer's diet. It is reasonable to assume that the betterment of health and happiness has resulted. The evidence or proof for such statements may be found in practically every locality. We have only to think of the uses of refrigerator cars and trucks, home freezers, community food lockers, cold storage plants, home refrigerators, and other refrigeration means and equipment.

The preservation of foods and the extension of uses have been due chiefly to the rapid growth and practical application made of refrigeration. Certainly the wide uses of highly perishable fruits and vegetables have gone a long way toward popularizing and emphasizing the value of many wholesome food products.

Some adjustments and changes in production are now being made. This has been due particularly to the enormous and rapid growth in recent years of a winter vegetable industry in the South, in California, Mexico, South America, Cuba, Puerto Rico and elsewhere. Some of the crops in most competition with the northern-grown and stored produce are cabbage, potatoes, onions, celery and carrots. Already there is a noticeable trend toward a shorter storage period for these vegetables in the northern sections.

COLD STORAGE

Modern commercial cold storage is now generally used chiefly for emergencies. For example, at certain seasons crops harvested and distribution methods may crowd and overload the markets. Without facilities for proper storage for even comparatively short periods, great losses are likely and continuous supplies may be interrupted or curtailed markedly. Perhaps the trend today is to harvest vegetables and fruits at the peak of their freshness, taste and flavor and rush them to the terminal markets under refrigeration by the swiftest transportation methods available. In so doing a higher quality product is furnished consumers, labor costs may actually be reduced and there is less waste and spoilage.

The type of storage best suited to large producers, handlers, shippers and others is usually cold storage. Here it is possible to regulate with precision temperature, moisture, aeration, sanitation and other factors that may tend to influence the keeping qualities. While the cost may be slightly higher than for some other types of storage, yet the hazard against losses may be considerably less and the chances for placing vegetables and fruits of high quality on the market are vastly improved.

TRANSPIRATION OF PLANT TISSUES

The evaporation of water from living plant tissues is known as transpiration. Water is also formed in respiration through the exchange of gases or the absorption of oxygen and giving off of carbon dioxide. As a result,

fruits and vegetables in storage transpire or give off water. The amount lost may be partly or completely replaced by the water formed in respiration. When the amount lost and produced is equal for any given period, shrinkage may not occur. If the amount lost is greater than that produced, shrinkage takes place. The shriveling or shrinkage is approximately proportional to the amount of water lost. Water loss is avoided, therefore, wherever possible. Both plant and environmental factors may be responsible.

SOME PLANT FACTORS

Very succulent and tender plant tissues contain more water than harder and non-succulent tissues. Naturally tissues with a high water content lose water more rapidly than tissues with a low water content. Peach fruits, asparagus tips and young greens are good examples of very succulent tissues. On the other hand, more mature produce such as some varieties of apples, celery or onions represent products of comparatively low water content and may lose water slowly.

ENVIRONMENTAL FACTORS

Temperature.—As fruits and vegetables in storage transpire, the influence of temperature on their rate of transpiration is quite comparable to that of growing plants. The rate at which these products transpire in storage is dependent upon the temperature. This being true, high storage temperatures tend to induce rapid transpiration (loss of water) and a greater amount of shrinkage, while comparatively low temperatures have an opposite effect. Accordingly, fairly low temperatures are maintained in storage houses or structures.

Relative Humidity.—The amount of water vapor in the air compared with the amount when the air is fully saturated for any given temperature is the relative humidity. For any particular temperature, therefore, when the relative humidity is 50 per cent the air contains only one-half as much water as it would hold if it were saturated. It is assumed that with other factors of the storage conditions in satisfactory supply, the rate of transpiration is inversely proportional to the relative humidity. This means that a low relative humidity tends to cause a high rate of transpiration and a high humidity causes a low rate of transpiration. It is obvious, therefore, that a comparatively high relative humidity should be maintained to prevent shriveling and shrinkage in storage.

Most observations and experience has shown that vegetables and fruits should be held in storage at a relative humidity ranging from about 70 to 85 per cent. This is true because a humidity lower than 70 per cent generally causes shrinkage and it may become excessive or serious. Also, with a humidity greater than 85 to 90 per cent, conditions may become favorable for the condensation of moisture on the walls of the storage room, on the surface of the products and for the rapid growth and development of storage rots or diseases.

TABLE

This is a summary of the findings of good authorities on the requirements of vegetables and fruits in cold storage. Such information as the average maximum storage period, average freezing point, suitable temperature and relative humidity is given. In this connection, it should also be remembered that other important factors may have a profound influence on the storage life and quality of vegetables held in cold storage. Some of these are conditions under which the crops were grown, stage of maturity, harvesting and handling practices and transportation. Still other factors influencing the keeping qualities are facilities for prompt storage after harvest, varieties grown, and prevalence or absence of disease and insect injuries. Grading, packing and storing properly in clean and suitable containers is always essential for success.

Fruits

Commodity	*Temp. F.°*	*Rel. Humidity*	*Approx. Length of Storage*	*Avg. Freeze Pt. F.°*
Apples	31–32	85–88	2–8 mos. variety	28.44
Blackberries	31–32	80–85	7–10 days	29.15
Cherries	31–32	80–85	10–14 days	27.81
Dewberries	31–32	80–85	7–10 days	
Grapes Vinifera	30–32	80–85	4–6 mos.	24.60
Grapes American	30–32	80–85	3–4 wks.	28.16
Loganberries	31–32	80–85	2–5 days	29.51
Peaches	31–32	80–85	1–2 wks.	29.41
Pears	30–32	85–90	Bartletts 1–1½ mos.	28.46
			Fall & Winter 1–7 mos.	27.25
Plums	31–32	80–85	1–2 wks.	28.53
Quinces	31–32	80–85	3–4 mos.	28.12
Raspberries, Red	31–32	80–85	7–10 days	30.41
Raspberries, Black	31–32	80–85	7–10 days	28.76
Strawberries	31–32	80–85	7–10 days	29.93
Dried Fruits	32–50	70–75	1–2 yrs.	
Frozen Fruits	15–18		6–12 mos.	

VEGETABLES

Commodity	Temp. F.°	Rel. Humidity	Approx. Length of Storage	Avg. Freeze Pt. F.°
Asparagus	32	85–90	3–4 wks.	29.8
Beans, Green	32	85–90	3–4 wks.	29.74
Beans, Lima	32	85–90	shelled 15 days	29.74
			pods 3–4 wks.	29.74
Beets, bunched	32	85–90	7–10 days	26.90
Broccoli	32	85–90	10–15 days	29.20
Cabbage	32	90–95	3–4 mos.	31.18
Carrots, bunched	32	90–95	7–10 days	29.57
Cauliflower	32	85–90	2–3 wks.	30.08
Celery	31–32	90–95	2–4 mos.	29.75
Corn, green	31–32	85–90	4–8 days as it usually arrives	28.95
Cucumbers	50–60	80–85	6–8 days	30.50
Eggplants	50–60	85–90	10 days	30.41
Endive	32	90–95	2–3 wks.	30.90
Garlic, dry	32	70–75	6–8 mos.	25.40
Horseradish	32	85–90	4–6 mos.	26.40
Jer. Artichokes	31–32	90–95	2–5 mos.	27.50
Leeks, green	32	85–90	1–3 mos.	29.20
Lettuce	32	90–95	2–3 wks.	31.20
Watermelons	50–55	75–85	2–3 wks.	Flesh 29.20
				Rind 28.80
Muskmelons	50–55	75–85	1–3 wks.	Flesh 29.00
				Rind 28.50
Honeydew	50–55	75–85	3–4 wks.	Flesh 29.00
				Rind 28.20
Casaba & Persia	50–55	75–85	4–6 wks.	
Onions & Sets	32	70–75	5–6 mos.	30.09
Parsnips	32	90–95	2–4 mos.	28.90
Peas, green	32	85–90	1–3 wks.	30.03
Peppers, chili, dry	50–80	70–75	6–9 mos.	
Peppers, sweet	32	85–90	4–6 wks.	30.09
Potatoes	36–50	85–90	3–5 mo. at 40 degrees indefinitely at 36–38°	28.92
Pumpkins	55–60	70–75	2–6 mos.	30.15
Radishes	32	90–95	2–4 mos.	
Rhubarb	32	90–95	2–3 wks.	28.40
Rutabagas	32	90–95	2–4 mos.	27.10
Salsify	32	90–95	2–4 mos.	28.40
Spinach	32	90–95	7–10 days	30.64
Squashes	55–60	70–75	2–6 mos.	29.30
Sweet Potatoes	50–55	80–90	4–6 mos.	28.44
Tomatoes, ripe	50–55	80–85	7–10 days	30.38
Tomatoes, mature green	55–70	80–85	1–6 wks.	30.40
Turnips	32	90–95	2–4 mos.	30.23

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